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AUTHOR Theiss, Nancy Stearns, Ed.; And Others
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ABSTRACT

Seventy-four multidisciplinary activities for grades seven through twelve are contained in this revised edition of energy education lessons for Kentucky students. Section I helps students understand energy and the current crisis by studying laws which govern energy flow and using examples of how these laws illustrate stable energy utilization systems as found in nature. Section II provides instructions for building various workable models to illustrate the feasibility of alternative energy as a significant contribution to Kentucky's energy picture. Section III explains energy at home and in the schools in terms of the laws of thermodynamics, characteristics of systems of equilibrium, and the effect of particular kinds of energy on population. It addresses community issues including local sources of power, and local decision making and global issues including the impact of local energy decisions. The last section focuses on individual choices regarding lifestyle selections and their impact on the environment. It includes student worksheets. (Author/DC)

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K.E.E.P.
KENTUCKY'S ENERGY EDUCATION PROGRAM
ACTIVITIES FOR THE CLASSROOM
7 - 12

Edited By
Nancy Stearns Theiss
Fife Scobie Wicks
and
Noel Rueff

paid for by the Kentucky Energy Conservation Plan

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Tacy Fullerton
Franklin County Schools

Johanna Strange
Model Laboratory School

Mike O'Brien
Northern Kentucky University

David Wicks
Jefferson County Schools

Frank Howard
Kentucky Department of Education

Herb Petitjean
Pendleton County Schools

Anne Kannapell
Country Day Schools

Linda Grant
Boyle County Schools

Anne Renner
Jefferson County Schools

Terry Wilson
Murray State University

David Siegenthaler
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Jefferson County Office of Environmental Policy

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KENTUCKY'S ENERGY EDUCATION PROGRAM
7 - 12

TABLE OF CONTENTS

ACTIVITY NUMBER	TITLE	PAGE
SECTION I:	FOREVER AND A DAY . . . ENERGY BEGINNINGS	1
1	AN ENERGY RESOURCE CENTER	3
2	NO ENERGY TO SPARE	4
3	PEDAL POWER	5
	"Figure 1, Bike Illustration"	6
	"Figure 2, Bike Illustration"	7
	"Pedal Power Worksheet"	8
4	HEAT TRANSFER AND CONVERSION	9
5	ENERGY AND THE LIVING WORLD	10
	"Energy and the Living World Reading"	11
	"Solar Radiation Distribution"	13
	"Greenhouse Effects"	14
	"Photosynthesis in Plants"	15
	"Plants Energy Pyramid"	16
	"Energy Flow Through a Food Chain"	17
	"Winds"	18
	"Water Cycle"	19
6	MEASUREMENTS OF ENERGY	21
	"Conversion Factors"	23
	"Energy Transformation"	24
	"Energy Math"	25
7	PASSWORD	27
8	FUSE THESE FUSION WORDS	28
	"Fusion Crossword Puzzle" answers	29
	"Fusion Puzzle"	31
9	THE SHADOW KNOWS	33
10	ENERGY RELAY	34
11	PILE-UP	35
12	DON'T EAT THE CHICKEN	36
13	TESTING FOR STARCH	37
14	PLANTS STORE ENERGY	38
15	IS THAT WHAT I REALLY EAT?	39
16	HOW FAR DOES YOUR BREAKFAST TRAVEL?	40
	"Production of Food by Producers Chart"	41
17	WHAT'S FOR DINNER?	43
18	SQUIRREL COMPETITION	44
19	FOOD CYCLE ENERGY STEPS	45
SECTION II:	THE FUEL AND THE FLOW . . . WHERE DOES IT GO?	47
20	MECHANICAL EQUIVALENT OF HEAT	49
21	HOW HOT IS IT?	51
22	WIND MACHINES	52
23	I'LL HUFF AND I'LL PUFF	53
24	SOLAR-GIZE	54

ACTIVITY NUMBER	TITLE	PAGE
25	SOLAR CONSTANT	55
26	SOLAR MODELS	56
	"How to Make a Sundial"	57
	"How to Make a Solar Cooker"	58
	"How to Make a Solar Fruit Dryer"	59
	"If You Can't Stand the Heat, Get Out of the Collector"	60
	"How to Make a Solar Greenhouse"	61
27	THE HOT SPOT	63
28	NUCLEAR POWER	64
SECTION III:	ME AND MY HOMETOWN . . . HOW DO I USE MY ENERGY?	65
29	ENERGY GRAFFITI	67
30	FEELINGS	68
31	ENERGY ATTITUDES	69
	"Which Is the Most Important?"	71
32	WHOSE RIGHTS ARE RIGHT?	73
33	ENERGY SONGS	74
34	SHORTAGE!	75
35	ENERGY NEEDS	76
36	METER READERS	77
37	ENERGY RESOURCES IN KENTUCKY	78
	"Outline Map of Kentucky"	79
	"Electric Power Plants"	80
	"Kentucky Coalfields"	81
38	THE GOOD 'OLE DAYS	83
	"The Good 'Ole Days" worksheet	84
39	ENERGY IN THE NEWS	85
40	HOW MANY MILES PER GALLON?	86
41	GAS RATIONING	87
42	CAR SURVEY	88
43	THE OIL-Y BIRD GETS THE WORM	89
44	ENERGY FLOW	90
45	IT'S A RAW DEAL	91
46	TRIP TO A POWER PLANT	92
47	WHO PAY'S THE PRICE?	93
48	HOW FAR SHOULD WE GO?	95
49	WHEN THERE IS NOT ENOUGH	96
50	ENERGY USE AROUND THE WORLD	97
51	FOOD AND THE LIFEBOAT ETHIC	98
52	IS THERE AN ENERGY CRISIS ON SIGMA DRACONIS IV?	99
SECTION IV:	USES AND ABUSES OF OUR ENERGY RESOURCES . . . WASTE NOT, WANT NOT	101
53	and it greW, and it GREW, and IT GREW	103
54	STAIRWAY TO HEAVEN	105
55	RAIN, RAIN, GO AWAY	106
56	WHO'S GOT THE HAZARDOUS WASTE?	107
57	CAN WE TAKE IT?	108
58	EXPONENTIAL GROWTH OF CONSUMPTION . . A COMPUTER PROGRAM	109

ACTIVITY NUMBER	TITLE	PAGE
59	WATTS UP?	110
60	FLORESCENT VS. INCANDESCENT LIGHTING	111
61	RESIDENTIAL ENERGY CHECKLIST	112
	"Residential worksheets"	113
62	INSULATING AN ICE CUBE	119
63	IS YOUR HOUSE DRAFTY?	120
64	SUMMER IN THE CITY	121
65	HOW DOES YOUR GARDEN GROW?	122
66	THE HOME OF THE FUTURE	123
67	AN ENERGY MENU	124
	"Energy Menu Checklist"	125
68	PROCESSING FOOD BY CANNING	129
69	HOW MUCH BIO IS IN THE MASS?	130
70	METHANE FROM MANURE	131
71	COMPOST IT!	132
	"How to Make a Garbage Pail Compost"	133
72	BOTTLES OR CANS?	135
73	RECYCLING PAPER	136
	"Man in the Environment"	137
	"How to Make Recycled Paper"	139
	"Don't Throw Your Trees Away"	141
74	AN ENERGY FAIR	143
BIBLIOGRAPHY		145
THE ENERGY GAME		

SECTION I: FOREVER AND A DAY . . . ENERGY BEGINNINGS

Natural systems have evolved mechanisms by which to make the maximum use of available energy while optimizing their ability to survive. Howard and Elizabeth Odum (Energy Basis for Man and Nature) have observed 5 major characteristics of a system in equilibrium:

1. storages of high quality energy
2. feedbacks of work from storages to increase inflows
3. recycling materials as needed
4. control mechanisms that keep the system adapted and stable
5. setting-up exchanges with other systems to supply special energy needs.

To understand energy and our current "crisis", it is necessary to understand the laws governing all energy flow. In this first section activities were organized in order to show examples of how these laws illustrate stable energy utlilzation systems as found in nature.

AN ENERGY RESOURCE CENTER

1

ACTIVITY:

Have students begin an Energy Resource Center for the school. This project would require at least one semester -- perhaps an entire shcool year. Some tasks would include:

Develop a vertical file wywtem which contains timely information on such topics as energy production, energy consumption, environmental problems, energy economics problems, alternate energy sources, and energy conservation measures.

Compile a bibliography of available school and community print and onoprint materials on energy.

Provide copies of a current listing of institutions and agencies which can provide information on energy.

Write to local, state and federal agencies explaining the Centers' purpose, requesting assistance and material.

Compile a list of community leaders who can speak on energy topiscl

Make energy information available to students, teachers, parents, and community members.

Prepare a work schedule for students who will assis in the center --perhaps with the school librarian as the supervisor.

CONCEPT:
To compile information on energy topics for class utilization.

SUBJECT:
Social Studies
Science
Math
Language Arts

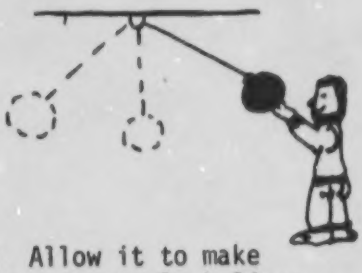
MATERIALS:
Resource materials

NO ENERGY TO "SPARE"

2

ACTIVITY:

Attach a screw eye into a bowling ball and suspend the ball from the ceiling by a long rope. Stand with the back of your head against the wall. Pull the pendulum to such that the ball will rest against the tip of your nose. (see illustration)



Release the ball, DON'T PUSH IT!!!!! Allow it to make a complete swing and return. Show htat you truly believe in the Law of Conservation of Energy by not flinching!

Points to bring out in class discussion.
a)Enough energy was provided to life the ball to your nose, there is no place it could get the extra energy to hit you.
b) Explaing the two uses of the word "conservation" in the Law of Conservation of Energy and the usual term Energy Conservation.
c) The ball will in fact fall somewhat short of your nose. Point out that this energy was not destroyed (although is has been diverted into a non-usuable form). Where did it go?
d) A story is told of a student who sneaked into a physics lecture room one evening to show-off to his girlfriend. He lifted the ball to his nose and gave it a good PUSH. He illustrated how energy could change from one form to another, a CONCUSSION!

CONCEPT:

Energy is neither created nor destroyed

SUBJECT:

Science - physics

MATERIALS:

A bowling ball
Screw eye
Rope
Hook in ceiling

PEDAL POWER

3

ACTIVITY:

The students should be familiar with the following information:

a) Mechanical Advantage = Force out/Force in

b) Work = Force x Distance

c) Circumference = x Diameter

Use an exercise stand or make a stand such that the rear wheel if free to turn. (If you have a sufficiently high teacher's lecture desk, some clamps and a few boards will suffice, See Figure 1)

Have one student attach a spring balance to the front pedal and another student a attach a spring balance to one of the spokes of the rear wheel. Have both of them pull tangentially and record the forces. See Figure 2.

Determine the distance that the pedal travels in one turn and the distance that the rim turns for one turn of the pedal.

Fill-in the line on the worksheet (Figure 3) for the gear being used.

Continue this for all the other gears. (It may help the student make comparisons if an effort is made to keep the force at the pedal constant.)

Discussion questions:

How does the work put in compare to the work gotten out?

What is the advantage of using the low gear? the high gear?

How do the sizes of the front and rear sprockets compare in the low gear? the high gear?

Would it be possible to design a gear such that one could go up hill very fast without having to use much effort?

CONCEPT:

Energy is neither created nor destroyed.

SUBJECT:

Science
Math

MATERIALS:

Multi-speed bicycle
Bicycle stand (see instructions)
2 Spring scales
Ruler
Figure worksheets 1,2 and 3 per student

Figure 1
Worksheet 1

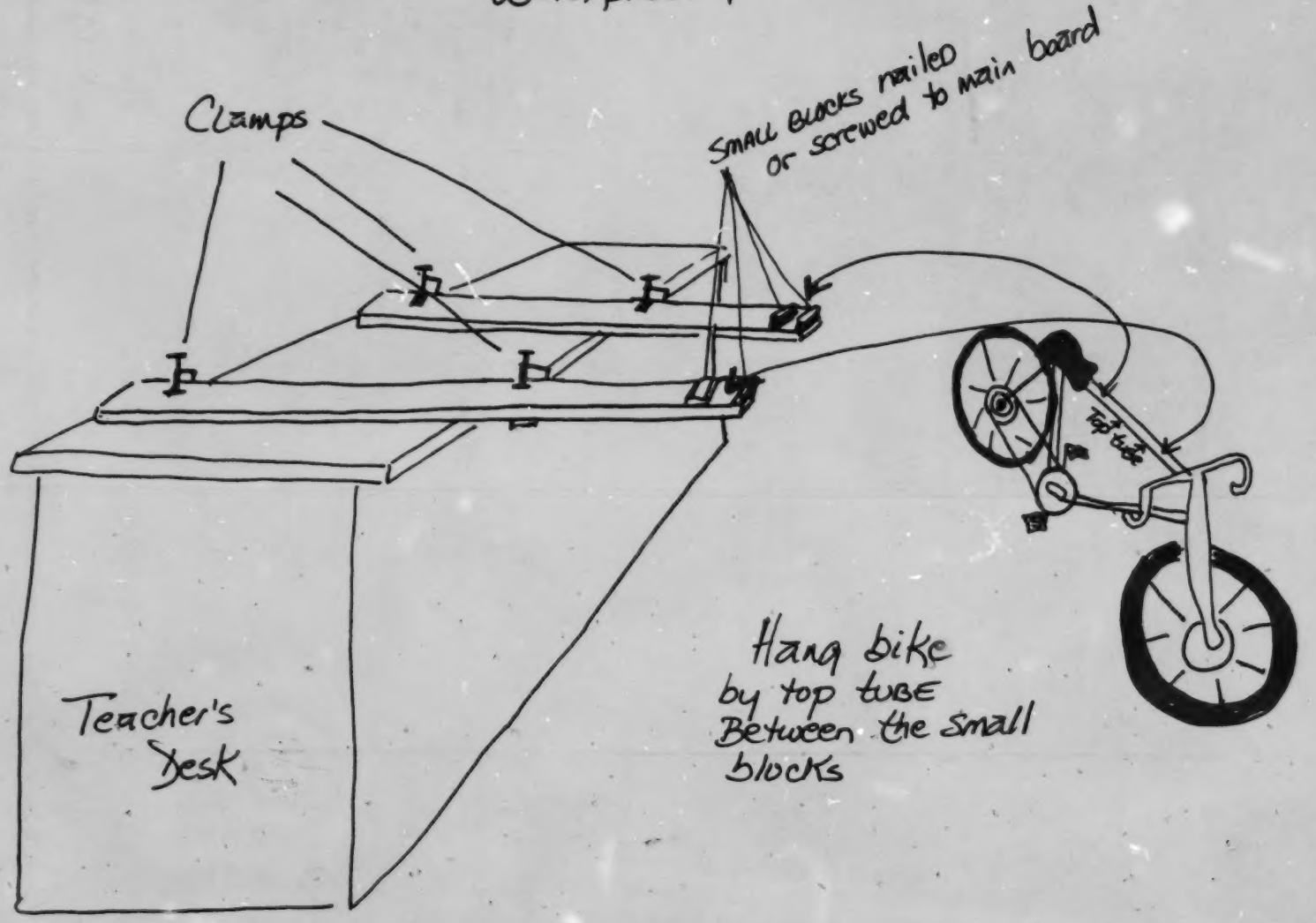
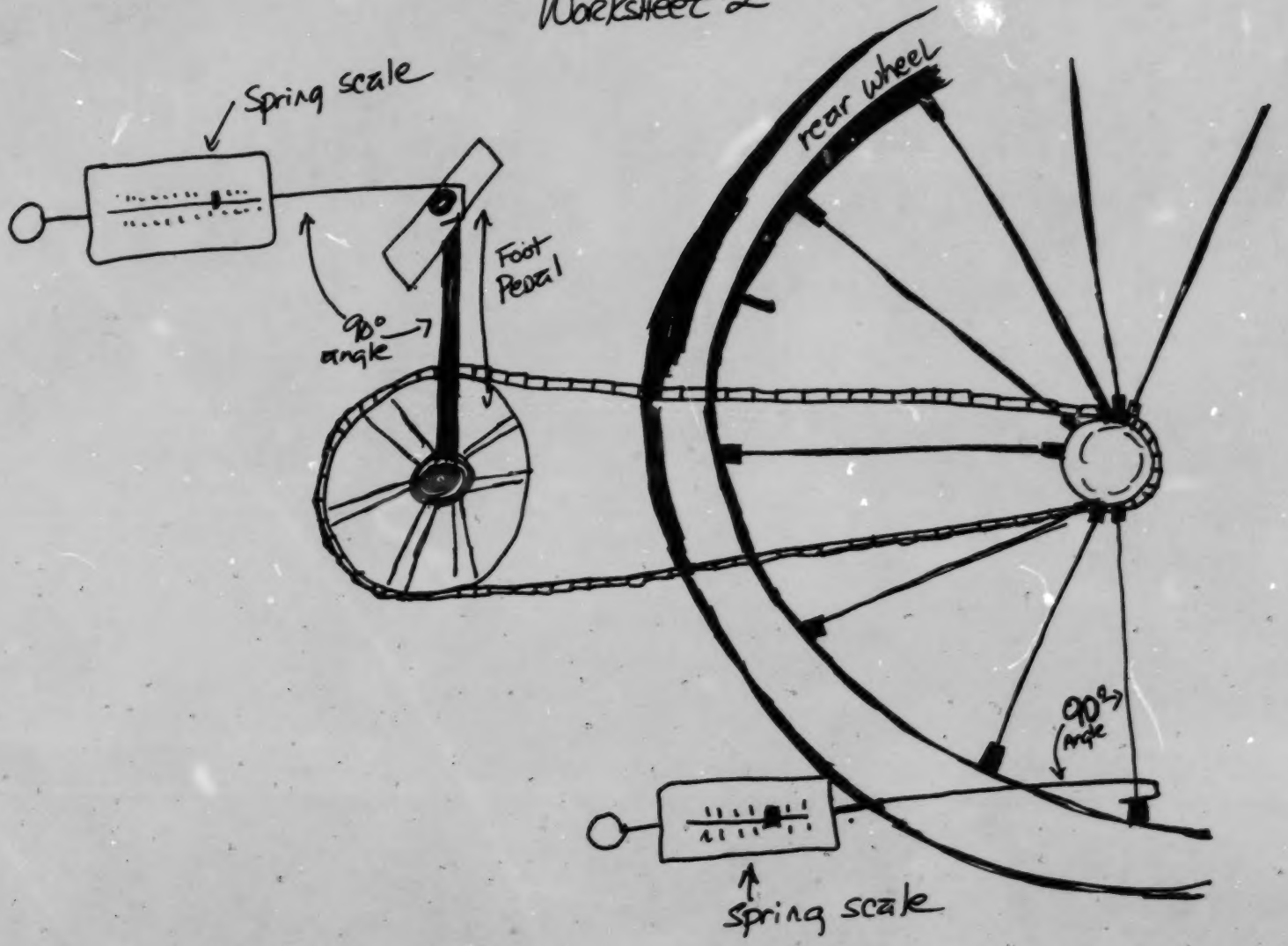

Clamps
Small blocks nailed or screwed to main board
Top tube
Teacher's Desk
Hang bike by top tube Between the small blocks

Figure 2
Worksheet 2



PEDAL POWER (FIGURE 3)

GEAR	FORCE AT PEDAL	DISTANCE PEDAL MOVES	FORCE AT REAR WHEEL	DISTANCE REAR WHEEL MOVES	MECHANICAL ADVANTAGE	WORK DONE AT PEDAL	WORK DONE AT REAR WHEEL
1st							
2nd							
3rd							
4th							
5th							
6th							
7th							
8th							
9th							
10th							

HEAT TRANSFER AND CONVERSION

4

ACTIVITY:

Set up the apparatus as shown so that you are heating ½ of a test tube of water and conducting the steam to a second test tube which should be immersed in a beaker of cold water.

A thermometer should be placed in the beaker of cold water and an initial reading should be made.

A second beaker of cold water with a thermometer in it should beplaced near the first.

Heat the test tube containing the water until half is boiled away.

While heating the water, periodic temperature readings of both beakers of water should be made and recorded on a graph.

Have the students explain the results of the data collected by answering the following questions:

a. In what state of matter did the water travel from the first to second test tube?

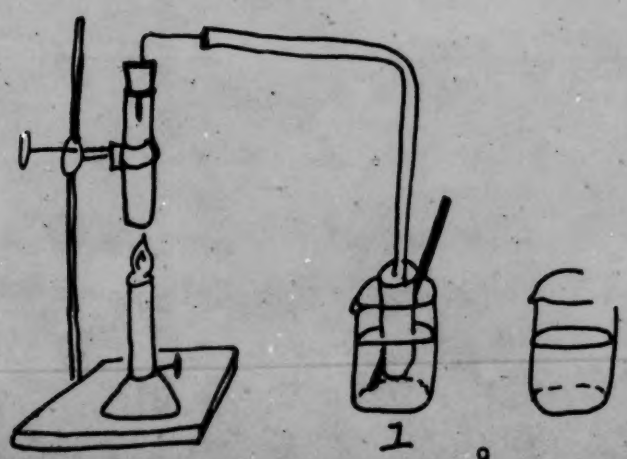
b. What happened to the temperature of the water in both beakers?

c. What caused the temperature results?

d. Which state of matter ow water contained more energy?

e. Can energy be transferred from one place to another by changing the characteristics of a substance with heat?

Think of an example of this process found in nature.



1

CONCEPT:
All conversion processes use energy or lose heat energy.

SUBJECT:
Science
Math

MATERIALS:

Alcohol burner or heat source
2 Test tubes
One hole stopper
Right-angle glass bend
Rubber tubing
2 Beakers
2 Thermometers
Ring stand with clamps

ENERGY AND THE LIVING WORLD

5

ACTIVITY:

Distribute the following worksheets with your students. Read the material with the class and refer to the various diagrams as designated in the reading material.

This material was taken directly from:
Energy, Pennsylvania's Energy Curriculum, Pennsylvania Department of Education, 1977.

CONCEPT:

To review and discuss various energy sources and natural cycles.

SUBJECT:

Science
Social Studies
Language Arts
Math

MATERIALS:

Worksheets per student:

Energy & the Living World
Solar Radiation Distribution
Greenhouse Effects
Photosynthesis in Plants
Energy Pyramid
Energy Flow through a Food Chain
Winds
Water Cycle

ENERGY AND THE LIVING WORLD

The sun provides the energy that sustains life on earth. The sun has probably existed for some 5 or 6 billion years. It is really just an average temperature, middle-sized star when compared with the rest of the stars in the universe. What is so special is the earth's location in relation to the sun. The earth is just the right distance from the sun to support life as we know it.

The exact source of the sun's energy is not really known. It has been theorized that the sun is a giant fusion reactor, fusing hydrogen into helium and converting the mass difference into energy. It is believed that the sun produces more energy in one second than has been used by all people throughout human history.

The tremendous energy produced by the sun radiates out in all directions. Only a very small fraction (one two-billionth) ever reaches the earth's atmosphere. Not all of this energy reaches the earth's surface. In fact, 40 percent of the solar radiation is reflected back to space (mainly by clouds) 17 percent is directly absorbed by the atmosphere, including water vapor, clouds, and dust. The remaining 43 percent is absorbed by the earth, and is used to power the winds, water cycle, and ocean currents, and to support life. Actually, only about one percent of the incoming solar radiation is used to support life through photosynthesis. Figure #1 shows the distribution of the various proportion of solar radiation.

The earth's atmosphere plays an important part in regulating the temperatures here on the earth. Because of our atmosphere, we do not have the large temperature fluctuations that are found on the moon, which is, of course, the same distance from the sun as we are.

Another benefit provided by the atmosphere is what is called the "greenhouse Effect". We have said that 43 percent of the radiation from the sun, mostly visible light, passes through the atmosphere and is absorbed by the earth. This is transformed into heat (infrared radiation) and is radiated back toward space. The water vapor and carbon dioxide found in the atmosphere are good absorbers of heat. They then trap much of this heat energy and prevent it from immediately escaping back into space. This keeps the average temperature of the earth higher than it would be without the atmosphere (figure #2).

The greenhouse effect is also the center of one of our modern-day controversies. One group of scientists is proclaiming that, because of all the smoke we are generating by burning fuels, we are going to block off enough incoming sunlight to lower the earth's temperature several degrees, which would lower the earth's temperature several degrees, which would be disastrous. Another group of scientists argues that because of the large amount of carbon dioxide we are generating, also through burning fuels, we will trap more heat in the atmosphere, which would raise the temperature of the earth several degrees and also prove diastrous. Might the production of energy prove in some way to be the downfall of the human race?

Only green plants can directly use the incoming solar radiation. All other organisms must then depend on the green plants for their life support.

Green plants use solar energy in the process of photosynthesis, where the sun's energy is transformed into chemical energy and stored as food. As the sun beams down on a green plant, the plant is taking molecules of water, minerals from the soil, and carbon dioxide from the atmosphere, and is using the sun's energy to combine these molecules into various new arrangements to form sugars, starches, proteins, and vitamins. These new molecules contain the chemical energy that other organisms will then use to sustain their life. Figure #3 illustrates the process of photosynthesis.

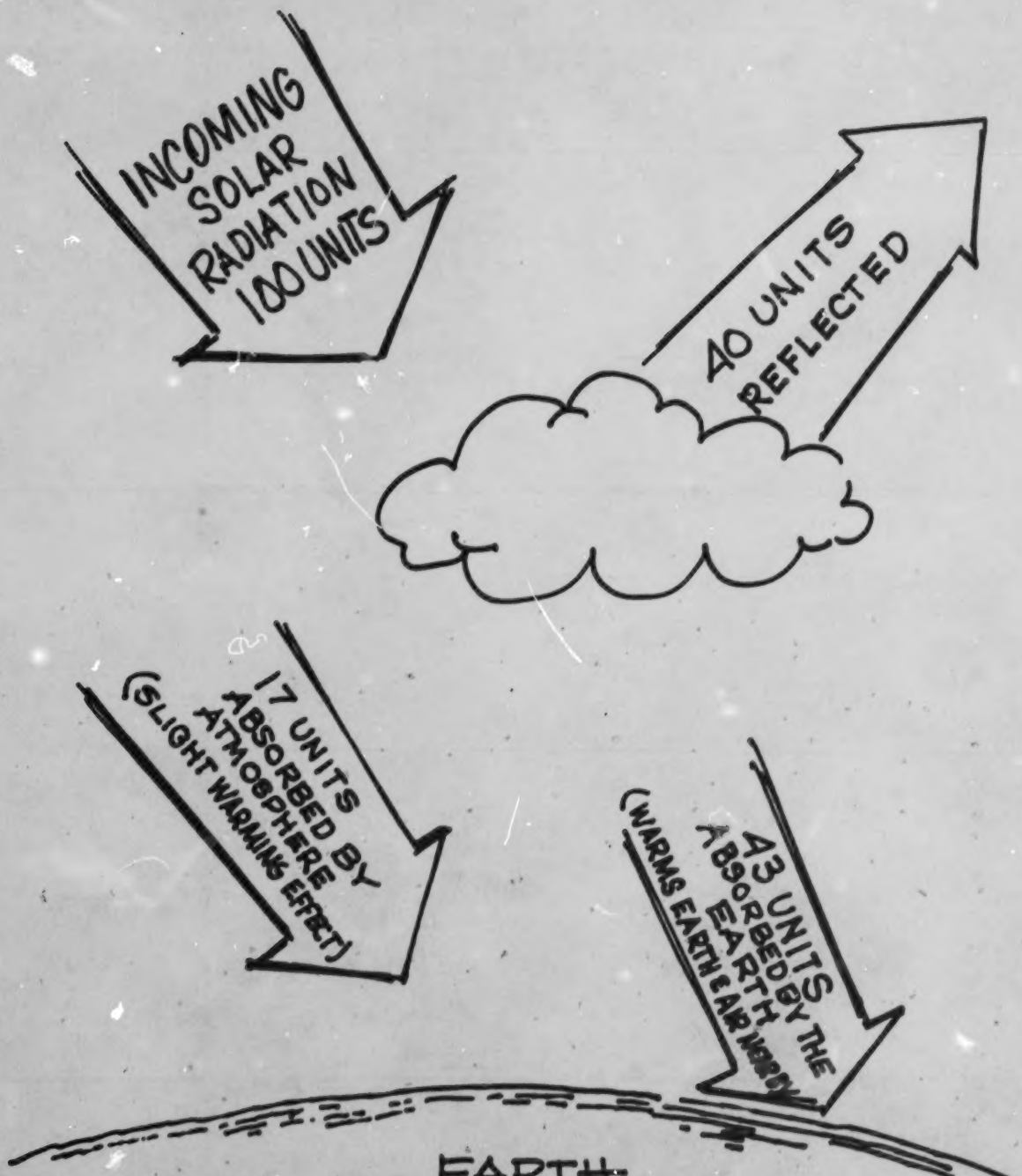
The process whereby animals use the energy stored by plants is called cellular respiration, and is really just the opposite of the process of photosynthesis. In cellular respiration, the food molecules (sugar, starch, and protein) are torn apart and energy is released, while carbon dioxide and water are produced. The energy released is then used by the animal for motion, growth, and other life processes.

Some of the energy from the plants is also stored again in the tissues and fat of the animal. Thus if an animal is eaten by another, the first animal is providing energy for the next animal - energy that actually originated in the sun.

This process of passing on the sun's energy can continue for only a limited time, because as in most energy transformations, energy is being lost at each step of conversion. As the energy is passed from one organism to the next, most of it (80 to 90 percent) is lost through respiration and heat, and only 10 to 20 percent is available to the next organism. Because of this loss, a country that eats much meat, like the U.S., has to produce many times more plants (grains) to supply everyone with food than a country such as India or China that eats more of the plants directly. In other words, eating meat is really a waste of energy because so much of the energy is lost as the corn and wheat are transformed into the meat of the animal. Figures #4 and #5 help illustrate this fact.

The sun provides the energy for many other phenomena besides life support. Wind is caused by the uneven heating and cooling of different parts of the earth by the sun. As the temperatures of two different regions of the earth differ, the air pressures over these regions also differ, and winds are produced (Figure #6). The energy in these winds may then be used for various purposes, including steering weather systems, driving ocean currents, shifting desert sands, and powering some machines.

The sun's energy also drives what is known as the water cycle (Figure #7). It all begins with the sun causing evaporation of water from the land and oceans. The water vapor later condenses and falls back to the land in the form of rain or snow. Gravity causes the water to run from the land back to the ocean.


INCOMING SOLAR RADIATION 100 UNITS
40 UNITS REFLECTED
17 UNITS ABSORBED BY ATMOSPHERE (SLIGHT WARMING EFFECT)
43 UNITS ABSORBED BY THE EARTH (WARMS EARTH & AIR NEAR IT)
EARTH

SOLAR RADIATION DISTRIBUTION

FIGURE #6

GREEN HOUSE EFFECTS

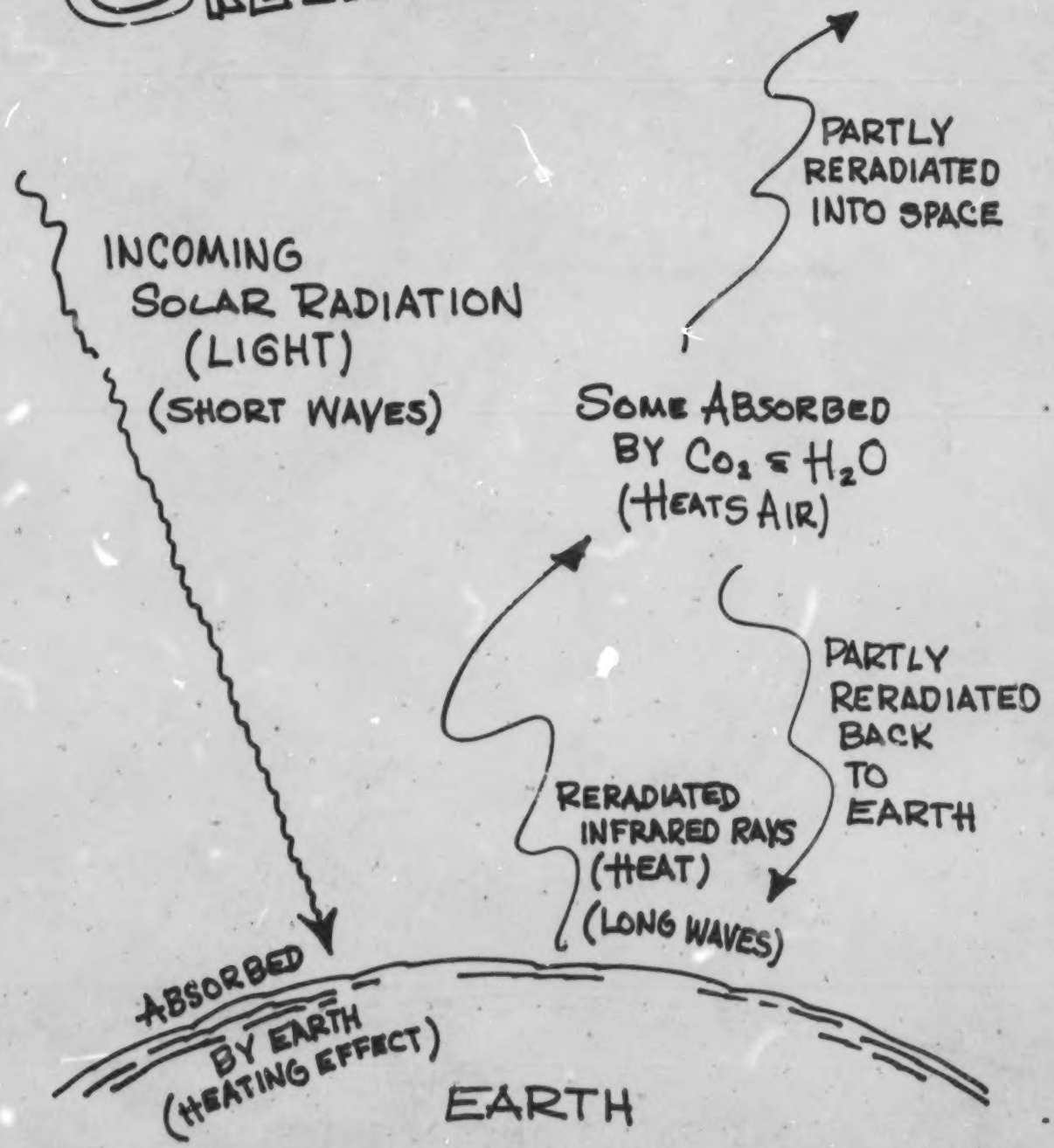
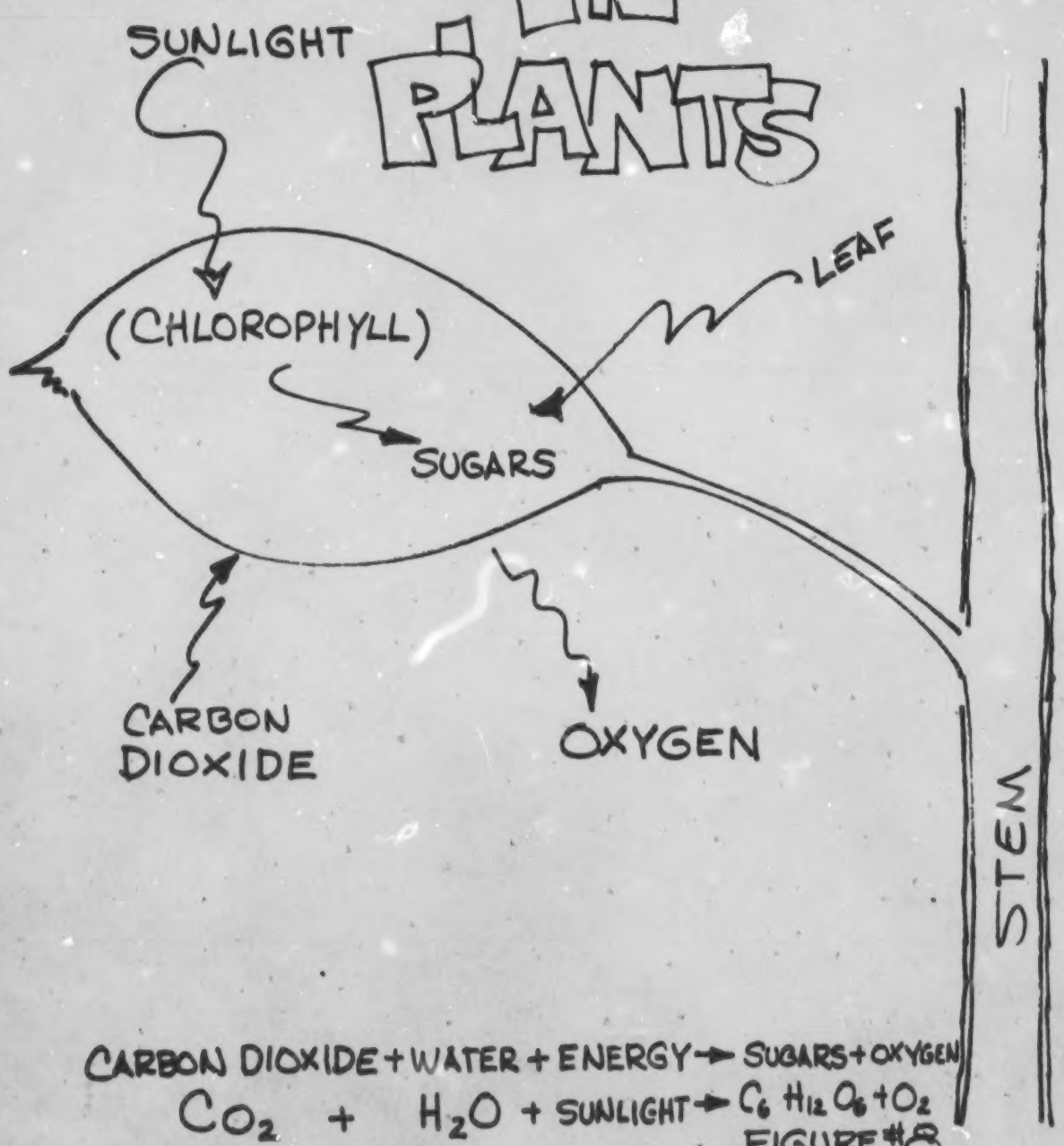


FIGURE #7

PHOTOSYNTHESIS IN PLANTS



CARBON DIOXIDE + WATER + ENERGY → SUGARS + OXYGEN

$CO_2 + H_2O$ + SUNLIGHT → $C_6H_{12}O_6 + O_2$

FIGURE #8

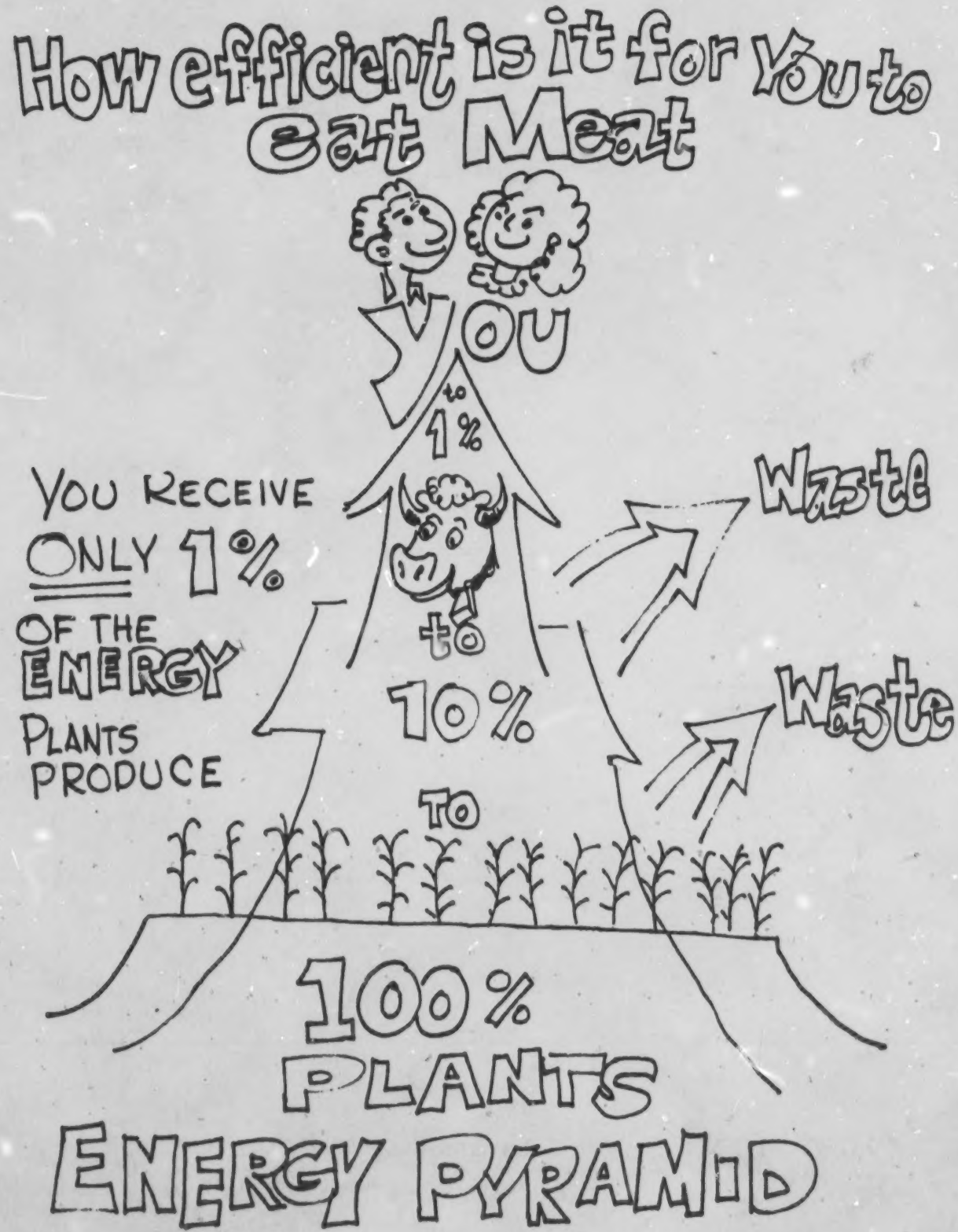
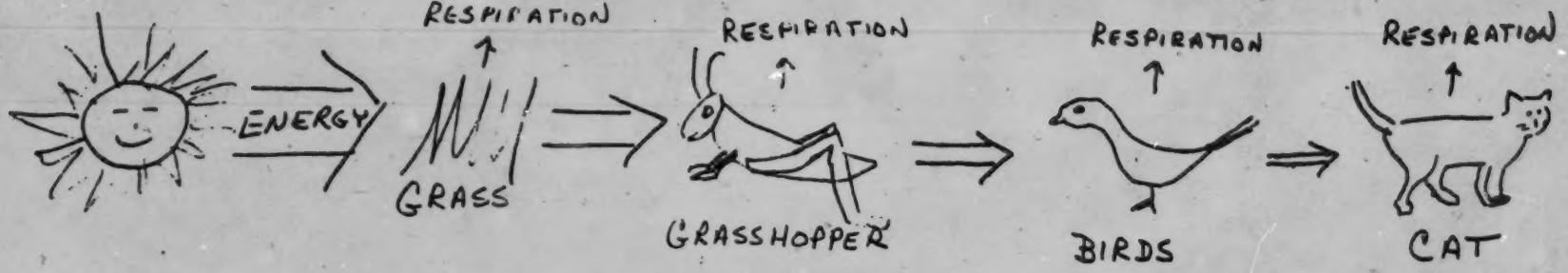

How efficient is it for You to eat Meat
YOU
1% to 10%
YOU RECEIVE ONLY 1% OF THE ENERGY PLANTS PRODUCE
Waste
Waste
100% PLANTS
ENERGY PYRAMID

FIGURE #9

ENERGY FLOW THROUGH A FOOD CHAIN



SOLAR ENERGY IMPUT	PRODUCERS (GREEN PLANTS)	PRIMARY CONSUMERS (HERBIVORES)	SECONDARY CONSUMERS (CARNIVORES)	TOP CONSUMER (CARNIVORES)
100,000 CAL	→ 1,000 CAL (1% OF SOLAR RADIATION	→ 100 CAL	→ 10 CAL.	→ 1 CAL.

Adapted from Energy and Environment

DECOMPOSERS

→ RESPIRATION
WASTE HEAT

FIG. #10

WINDS

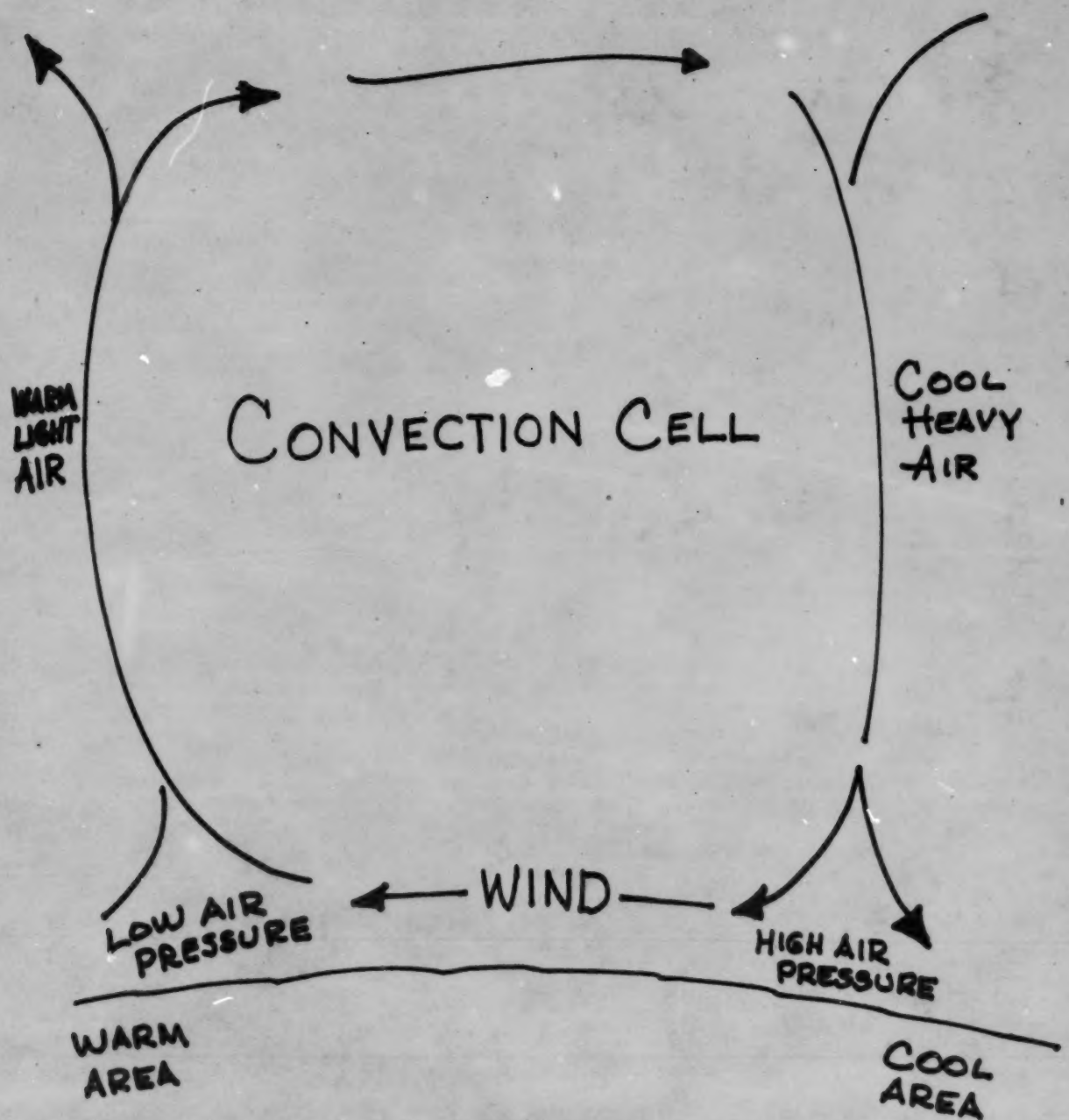


FIGURE 11

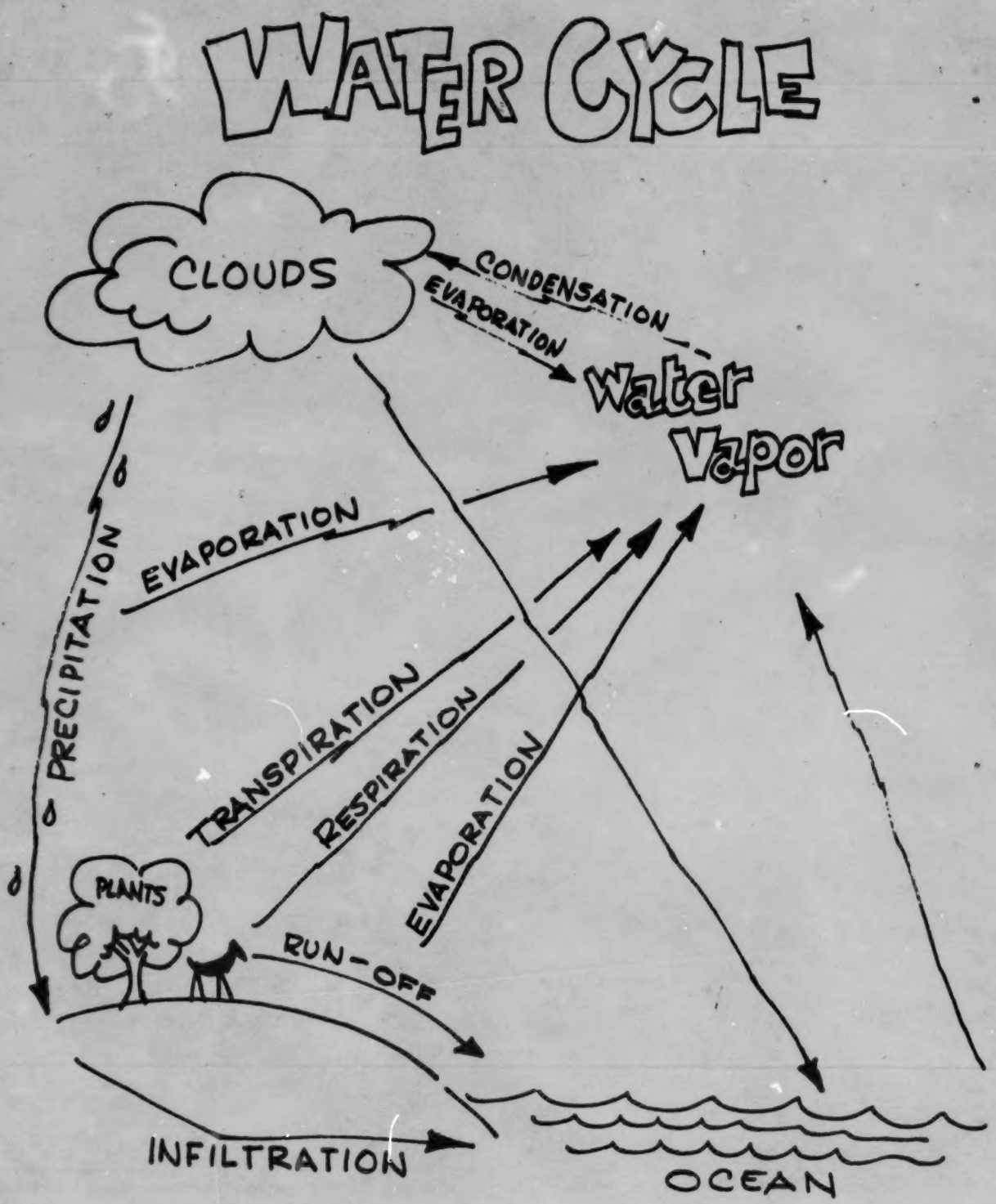

WATER CYCLE
CLOUDS
CONDENSATION
EVAPORATION
Water Vapor
EVAPORATION
PRECIPITATION
TRANSPIRATION
RESPIRATION
EVAPORATION
PLANTS
RUN-OFF
INFILTRATION
OCEAN

FIGURE #12

MEASUREMENTS OF ENERGY

6

ACTIVITY:

To be duplicated for the student:
Energy is measured in many ways. Don't let all the units of measurement confuse you. One can make meaningful and sometimes humorous comparisons amoung various energy sources simply by converting all information to the same unit of measurement. Here are some definitions, abbreviations, and conversion factors that may help.

MEASUREMENTS OF ENERGY

We need not concern ourselves with many sophisticated terms in energy measurement, but we do need some basic definitions to serve as tools in talking about energy.

A basic unit of energy measurement is the British Thermal Unit, or BTU. One BTU is the amount of heat energy that must be supplied to one pound of water to raise its temperature one degree Fahrenheit.

Energy from all fuels can be converted to BTU's. Approximate conversion rates are on Worksheet Conversion Factors.

The word power refers to the amount of energy used or produced in a given amount of time. One important unit of power is the watt. One watt is equal to .00948 BTU per second. One kilowatt is 1000 watts, while one megawatt is 1,000,000 watts.

The killowatt-hour is the familiar measurement of electricity. A kilowatt-hour (KWH) is 1000 watts of power used for one hour.

All eletric appliances and light bulbs are rated in watts. For example, a 100 watt light bulb will light for 10 hours with one KWH of electricity. An appliance with a rating of 1000watts will run for one hour on one KWH of electricity.

In biological processes, the unit of energy is the calorie. One calorie is the heat required to raise the temperature of one gram of water one degree Centigrade. The Calorie (note the upper case "C") is called the kilocalorie, and is equal to 1000 calories. One Calorie is about 4 BTU. (See Worksheet on Energy Transformation).

Note to teacher:

After presenting the above information to students distribute the Worksheet "Energy Math" for students to solve.

CONCEPT:

To become aware and utilize various units of measurement

SUBJECT:

Math
Science

MATERIALS:
Per student:

Conversion Factors worksheet

Energy Transformation worksheet
Energy Math Problems worksheet

This activity taken from: South Dakota Energy Scorecard, S.D. Office of Energy Policy.

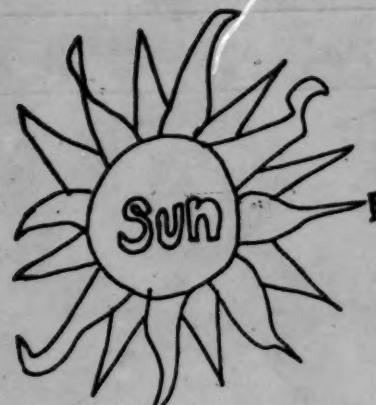
Table 1.

CONVERSION FACTORS

To convert from:	To:	Multiply by:
kilowatt-hour	Btu	3,412.8
ton bituminous coal	Btu	26,200,000
bbl crude oil	Btu	5,600,000
bbl residual oil (No.5)	Btu	6,200,000
gallon gasoline	Btu	125,000
gallon No. 2 fuel oil	Btu	138,800
cubic foot natural gas	Btu	1,031
Mcf natural gas	Btu	1,031,000
therm natural gas	Btu	100,000
gram calories	Btu	.00397
kilgram calories	Btu	3.97
cubic ft atmospheres	Btu	2.721
foot-pounds	Btu	.001284
horsepower-hours	Btu	2,546.14
horsepower-years	Btu	22,304,186.4
Langleys	Btu/sq.ft.	3.69
Btu	cubic centimeter atmospheres	10,405.6
Btu	cubic foot atmospheres	.36747
Btu	foot-pounds	777.694
horsepower	ft.-lb./sec.	550
horsepower	ft.-lb./min.	33,000
horsepower	ft.-lb./hour	1,980,000
Btu	gram calories	251.9958
Btu	kilogram calories	.2519958
Btu	horsepower-hours	.0003927
kilowatts	horsepower	1.34124
horsepower	kilowatts	.7547
horsepower	watts	754.7
Btu/sq.ft.	Langleys	.271
Btu	kilowatt-hours	.000283

Table 2

Energy Transformation



Light energy

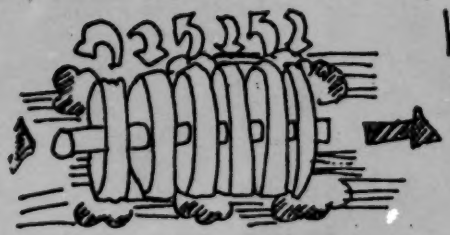
heat ↕ loss

coal
Chemical energy

heat ↕ loss

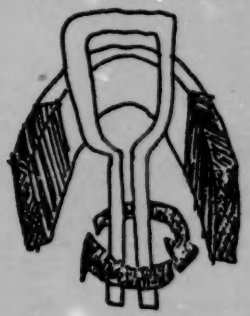
fire
Heat energy

heat ↕ loss =



Turbine
Mechanical energy

heat ↕ loss



Electrical generation
Electrical energy

heat ↕ loss

Light bulb
Heat and Light energy

ENERGY MATH

1. One gallon of milk provides about 2640 kilocalories (Calories) or about 10,480 BTU's. How many gallons of milk would you have to grink to get as mush energy as your car gets from one gallon of gasoline?

2. A 225 horsepower car consumes 225 horsepower hours of energy in one hour of driving or roughly 2,550 Btu's/H.P. hour x 225 H.P. hour = 573,750 Btu's. If this car were to run on :
   a. gasoline, how many gallons would is take?
   b. coal, how many tons would it take?
   c. electricity, how many kilowatt hours would it tak?

WHAT EQUALS WHAT?

Try fo find a match for each of these. Be careful: they may surprise you!

1. Energy equivalent of 1 barrel of oil.
2. Energy used ofr the manufacture of 20 aluminum cans using recycled aluminum.
3. 3 months' worth of electricity for a frost-free refrigerator.
4. Total energy use of 800 million Chinese in one year.
5. 350 degrees in your oven.
6. Paper needed to package food in 1 American fast food chain in 1 year.
7. Heat given by the burning of one cord of oak wood.

Match the above (1 - 7) with the below (a - g)

a. Energy used by the air conditioners of 200 million Americans in one year.
b. 325 degrees in your oven if you use stainless steel, ceramic or glass dish.
c. Energy equivalent of a man at hard labor for 2 years.
d. Energy used in the manufacture of aluminum can using only virgin aluminum.
e. 174 million pounds of paper.
f. 1 months' worth fo electricity for non-frost-free refrigerator.
g. Heat given by the burning of one ton of coal

ANSWERS

1 - c. A human being requires 341 BTU's of energy for one hour of normal activity.
2 - d. If you failed to recycle 2 aluminum cans, you would waste more energy than is used daily by a person in poorer lands.
3 - f. A frost-free refrigerator uses much more energy than a manual model
4 - a. The U.S. level of energy consumption is 6 times as high as the world average.
5 - b. These types of dishes conduct heat more effectively and thus do not require as hot an oven.
6 - e. This amount, 174 million pounds, requires a substantial yield of 315 square miles of forest for one year.
7 - g. The heat potential of one cord of wood (80 cubic feet) equals the heat potential of one ton of coal.

(Courtesy of Park Project on Energy Interpretation, Nation Recreation and Park Association.)

PASSWORD

7

CONCEPT:
To define and use energy related terms

SUBJECT:

MATERIALS:

ACTIVITY:

Divide the class into two groups of approximately equal ability. Choose one student from each team to give clues and have them set at the fron of the room. The game is played like the TV game "Password" except that each clue giver will be giving clues to his team rather than to one partner.

You may want to use the list of suggested words included, or add your own. Student should be familiar with the words before the game is played.

How the game is played:
Each of the clue givers is shown the password.

The clue givers then give one word clues althernately to their teams. You cannot use any form of the word in the clues.

After giving a clue, the clue giver chooses someone on his team to guess what the password is. If that team member guesses the correct word, his team scores, and you begin a new round using a new password.

If the team member guesses incorrectly, the turn goes to the other clue giver, who gives a new clue and chooses someone from this team to guess.

After the word has been guesses correctly by one team or the other, the new word goes first to the clue giver who did not start the previous round.

Scoring: 10 points for the team guessing the word correctly on the first clue: 9 points if the correct word is guessed on the second clue: 8 points if the team guesses the password after hearing the third clue, etc.

New clues should be chosen from each team after every three or four rounds have been played.

Possible words to be used:

turbine	magnet	volt	static
steam	circuit	friction	experiment
battery	water	kilowatt	reaction
generator	wind	electron	nuclear
energy	heat	compass	coal
electricity		appliances	gasoline
conversion		waste	
convert		insulation	
source		solar	

FUSE THESE FUSION WORDS

8

ACTIVITY:

Duplicate the Fusion Crossword Puzzle for the students to work.

CONCEPT:
To become familiar with terms dealing with the nuclear fusion process.

SUBJECT:
Science

TAKEN DIRECTLY FROM: Thinking About Energy, Secondar Studies Guide, State of Delaware.

MATERIALS:

Per student

x-word puzzle

Supplementary Activities

unit:

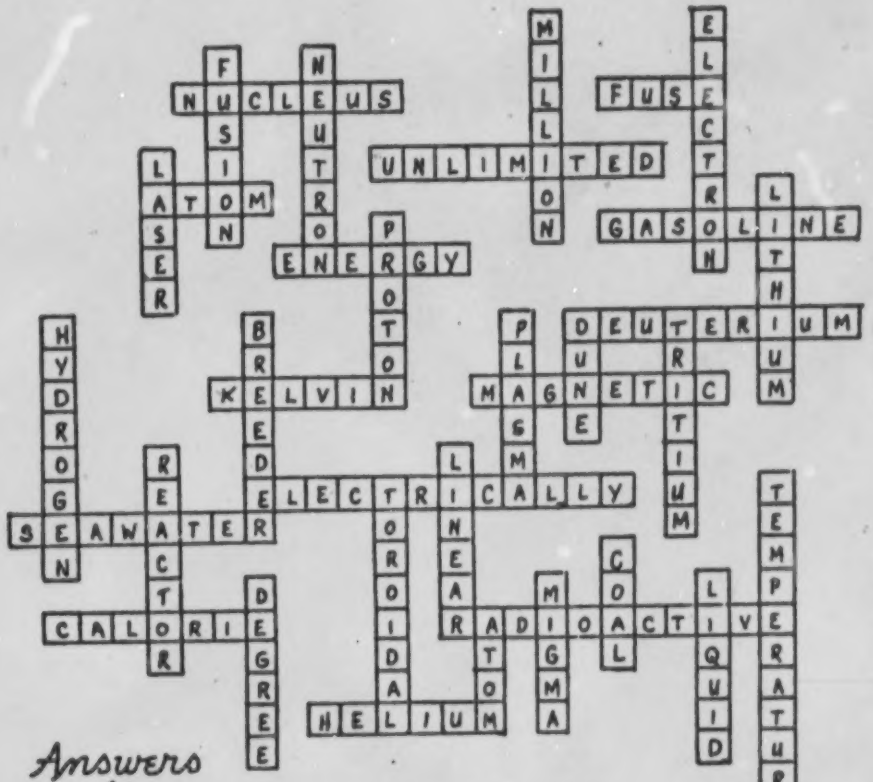
FUSION CROSSWORD PUZZLE

ACROSS

1. The central part of an atom
2. This is what the nuclei of atoms do during fusion
3. Some scientists believe our energy supply will be this way if we can perfect the fusion reaction
4. Smallest particle of any element which can still be identified as that element
5. One gallon of seawater can produce the equivalent energy of 300 gallons of _____
6. Ability to do work
7. A measure of temperature like Centigrade and Fahrenheit
8. A _____ field is one way to contain the charged gases during fusion
9. This is a source of deuterium
10. Atoms heated to a very high temperature form an _____ charged gas
11. A hydrogen atom with one proton and one neutron is called _____
12. One means of measuring energy
13. During the fusion reaction, tritium becomes _____
14. This element is a product of the fusion reaction.

DOWN

1. This type of beam is one way to raise fusion reaction to high temperatures
2. Type of reaction where two nuclei fuse and give off energy
3. The uncharged particle in the nucleus of an atom
4. The temperature necessary for fusion is about one ____ degrees Kelvin
5. These negatively charged parts of the atom could be fired in a beam at the fuel for fusion
6. The positively charged particle in an atom nucleus
7. This element in a liquid form creates a shield around the reaction
8. The lightest and smallest atom (element)
9. The fusion reaction can convert U238 to plutonium ten times faster than this kind of reactor
10. Electrically charged gas
11. Oil is sometimes found in areas with these sand _____
12. This is the heaviest form of hydrogen with one proton and two neutrons
13. This puzzle is concerned with one type of nuclear _____
14. Type of magnetic bottle which sometimes has leakage at the ends
15. Fusion must take place at an extremely high _____
16. Way of measuring temperature
17. Doughnut-shaped magnetic bottle for containing fusion particle
18. Same as 4 across
19. Special research is being done on a _____ cell which causes particles to collide in a figure 8 pattern
20. The energy available from fusion could be one thousand times greater than all energy available from all the remaining _____
21. Lithium is in this state when it is forming a shield for the fusion reaction

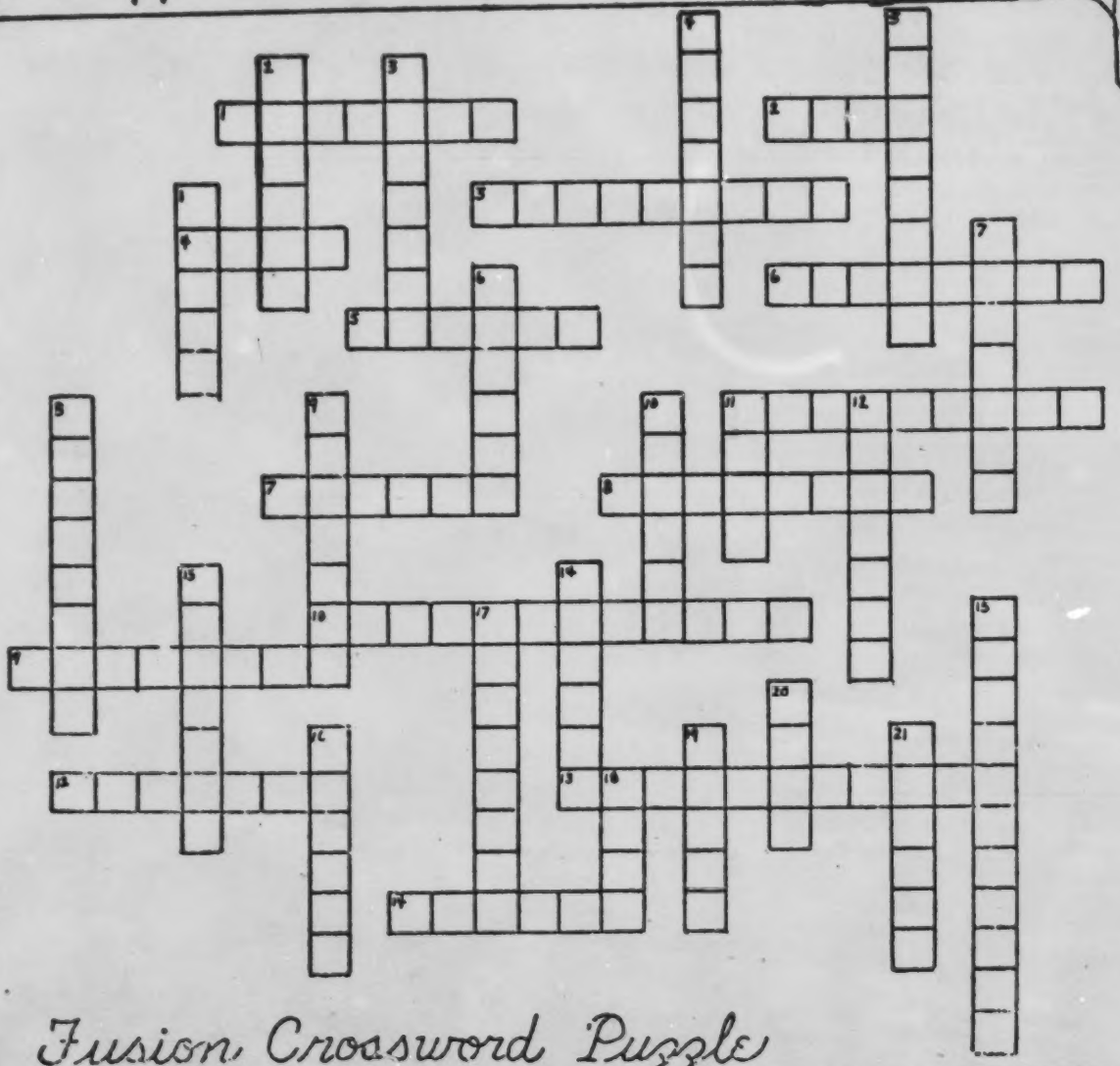


Answers for Fusion Crossword Puzzle

FROM: THINKING ABOUT ENERGY: SECONDARY STUDIES GUIDE - STATE OF DELAWARE

Supplementary Activities

Unit:



Fusion Crossword Puzzle

THE SHADOW KNOWS

9

ACTIVITY:

Find a vertical object in a flat sunlit area. This may range from a nail in a board place in a south-facing window to a flagpole in the school yeard. Pick a spot where you can make permanent marks as this activity will take several months and will produce a permanent display.

Every week or every other week, mark the end of the noonday shadow.

Discussions and/or out-of-class assignments may include:

Explaining the cause of the apparent motion.

Explaining why we have seasons.

How ancient peoples measured and celebrated the solstices, (plan your own celebration).

Make a sundial

How eaves and awnings can shade a house in summer and let the sun's heat in during winter.

How different active solar devices (home heating, water heating, heating an outdoor pool) might require different angles.

The current status of solar easement laws ("Right to Light", can neighbors build something which will block existing solar collectors in Kentucky). Compare this to laws in other states.

CONCEPT:

To become aware of alternate energy sources.

SUBJECT:

Science
Social Studies

MATERIALS:

Vertical object in a flat sunlit area

ENERGY RELAY

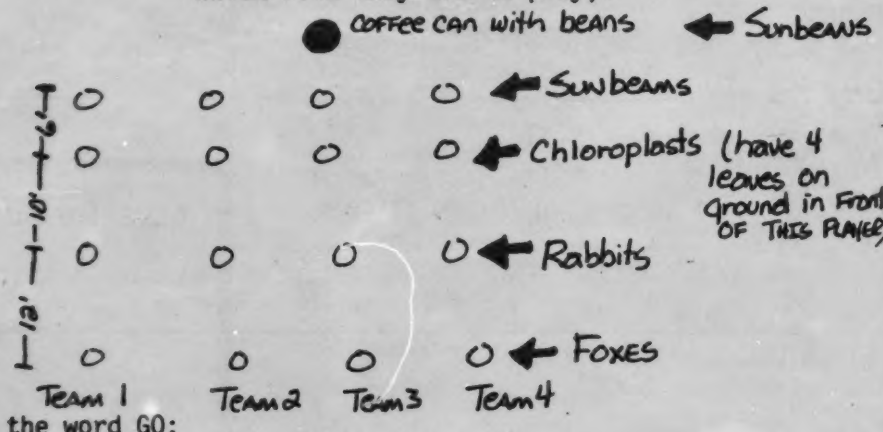
10

ACTIVITY:

Get students in groups of four:

Each group should collect 4 leaves.

Go to a field or yard and have each team set themselves up as follows: (be sure to assign each member of the team which role they are to play).



On the word GO:

Sunbeams carry sunbeans one at a time to chloroplasts.
(Sunbeans are the dried beans you have placed in a coffee can in the front of the sunbeams)

When chloroplasts have 5 beans, they pick up one leaf.

When chloroplasts have 2 leaves, they carry one leaf to the rabbit (it took one leaf worth of energy to carry it).

When the rabbit gets a leaf, it takes <u>one</u> hop towards the fox.

THE FIRST TEAM TO COMPLETE THE FOOD CHAIN BY REACHING THE FOX WINS!

Be sure to discuss with your class who was the most tired in this game and why.

CONCEPT:
Natural systems make maximum use of energy available.

SUBJECT:
Science

MATERIALS:
Coffee can
Dried beans
Leaves

PILE-UP

11

CONCEPT:
Animals depend on green plants for food (energy)

SUBJECT:
Science

MATERIALS:

ACTIVITY:

Have students :

Make a list of animals that eat animals.

Trace the energy supply of the food animals through a food we.

As a group activity:

Get your students together

Go outside to a grassy area

Build a gyramid. and a role to each trophic level.

"DON'T EAT THE CHICKENS"

12

ACTIVITY:
This activity must follow class discussion on energy pyramids.

The student is stranded on an island. He/she has an unlimited supply of water and shelter. Also, on this island is a crate of live chickens (hens only) and a case of wheaties.

Assuming both of these sources will be used as food, which would be the most efficient use of food energy.

1. Eat the wheaties first and then the chickens (chickens lose weight while wheaties are eaten).
2. Eat chickens first and then the wheaties (least energy).
3. Feed the wheaties to the chickens and then eat the chickens (too many energy transfers)
4. Feed the wheaties to the chickens, eat half the chickens and allow remaining half to lay eggs, allow the eggs to hatch and start cycle over again (too many energy transfers, no rooster)
5. Add your own choices.
6. Allow students to discuss or research before answering problems.

CONCEPT:
Energy transfers-trophic levels

SUBJECT:
Home Ec
Science

MATERIALS:

TESTING FOR STARCH

13

ACTIVITY:

Have your students try the following experiments to find-out how rapidly plants make starch.

1. Make an iodine solution by adding 5 ml iodine to 45 ml water

2. Place a geranium in a dark closet for 2 -3 days - the leaves will begin to turn white!

3. Now test a white leaf from the geranium by crushing it in a small amount of water. What happens?

4. Test the potato for starch! Cut the potato in half and place a few drops of iodine solution on the potato. If it turns blue it has starch in it!

5. Remove several leaves from the geranium. Cover in places with black paper strips and place in the sun for 2 hours. How long does it take for the leaves to turn green? Now test the leaves for starch again.

6. Make a testing solution with red cabbage and see what colors it produces in vinegar, baking soda, soap, etc. Record the color changes and compare with the results of your earlier experiments.
(To make the testing solution, boil red cabbage and pour off the liquid. Cool the liquid, then use is to test your materials.

7. Vinegar is an acid: see what color it becomes in your red cabbage solution. Test other materials, if they become the same color, they're acids, too.
Can you find something that changes red cabbage solution to a different color?

CONCEPT:
To demonstrate that plants are the primary producer of the food chain.

SUBJECT:

Science

MATERIALS:

Tincture of iodine
Water
Geranium plant
Potato
Sugar
Graduated Cyclinder
Heat source
Black paper
Paper clips
Red cabbage
Various items to test

PLANTS STORE ENERGY

14

ACTIVITY:

The following are suggested activities that may be done by each student, as a group or as a entire class. You may want to duplicate each activity on a card to be used for your learning center.

Action:

1. Find all the ways plants store energy.
2. Find the places in which plants store energy.
3. Find a plant that does not store energy.
4. Which plants store energy longest? shortest?
5. Design a plant you think would be an efficient energy storage container.
6. Compare natures plant containers with manmade containers. Which is better designed?
7. Design a container for some kind of energy using nature's designs.

CONCEPT:
To demonstrate that plants are the primary producers in the food chain

SUBJECT:
Science

MATERIALS:

Various items that students could use in #5 & #7, ie., wood, paper, glue, string, ...

IS THAT WHAT I REALLY EAT?

15

ACTIVITY:

Have students list all the food that the school cafeteria served for lunch on a given day.

Name each food item by its original form in nature. A chart may be useful as shown below:

Roast beef	-	cooked muscle tissue of a cow	- grass - sun

Optional: Have each student list what they had to eat in their last meal at home on one side of an index card. Next turn over the card and have them write down the original name for their food! Example: Jello would be hooves from a mammal + sugar + water. Have students begin to write down some of the ingredients used in various packaged foods. Be sure to point out the many ingredients it takes to make just one product like cereal. How much energy goes into making just that one item?

CONCEPT:

The sun is the original source for all energy in food production.

SUBJECT:

Science
Social Studies
Agriculture
Home Ec

MATERIALS:

Pencil
Paper
Index cards

HOW FAR DOES YOUR BREAKFAST TRAVEL?

16

ACTIVITY:

Ask students to make a collage of the foods they ate for breakfast.

Using a large world map find out where these foods originated. Have a large cut-out of Kentucky. Select foods that are not highly processed but composed of one main ingredient, i.e., bananas---South America, orange juice---Florida, lemons---California. Using yarn make contact between our town and the origin of the food.

Discuss iwth the class how far some foods travel to get to us, and how some foods can be found closer to home. What foods we might have to do without if fuels to run trains, planes, trucks become less available?

Ask students to bring in pictures of favorite foods. Put on the blackboard for display. Discuss what foods we do not have regionally. What foods are we used to or depend upon that are not locally available? Are they necessary to our diet or are they a "luxury"?

Adapted from: Energy, Food and You, State of Washington Department of Public Instruction.

CONCEPT:

Energy can be conserved by eating only locally produced foods.

SUBJECT:

Home Ec
Science
Social Studies

MATERIALS:

Per Class:

Food Production Chart

Taken from: Energy, Food, and You, State of Washington Department of Education, 1978.

PRODUCTION OF FOODS BY FIRST, SECOND, AND THIRD LARGEST PRODUCERS

	First	Second	Third
Wheat	U.S.S.R.	U.S.A.	China (People's Republic)
Corn	U.S.A	U.S.S.R.	Brazil
Barley	U.S.S.R.	U.S.A.	United Kingdom
Rice	China (P.R.)	India	Pakistan
Potatoes	U.S.S.R.	Poland	East Germany
Tobacco	U.S.A.	China (P.R.)	India
Cocoa	Ghana	Nigeria	Brazil
Tea	India	Ceylon	China (P.R.)
Coffee	Brazil	Columbia	Ivory Coast
Apples	France	U.S.A.	Italy
Bananas	Brazil	Ecuador	India
Citrus Fruit (oranges, etc.)	U.S.A.	Brazil	Spain
Grapes	Italy	France	Spain
Soya Beans	U.S.A.	China (P.R.)	Brazil
Sunflower seed	U.S.S.R.	Argentina	Romania
Peanuts	India	China (P.R.)	Nigeria
Milk	U.S.S.R.	U.S.A.	East Germany
Cheese	U.S.A.	France	U.S.S.R.
Beef	U.S.A.	U.S.S.R.	Agentina
Mutton/Lamb	U.S.S.R.	Australia	China (P.R.)
Pork	China (P.R.)	U.S.A.	U.S.S.R.
Sugar (cane)	Cuba	Brazil	India

WHAT'S FOR DINNER

17

ACTIVITY:

The following is a game to do with your class.

Instructions:

When many different species eat the same food, they must compete with each other to get enough to eat. The amount of food energy available may cause a species to
- leave the location
- become endangered or extinct
- modify to eat another food source

Divide your class into 3 groups:

The Greens - the "producers". The majority of students should be here. Each student should have green flag or armband.

The Blues - The "herbivores". Fewer students in this group, with blue flags or armbands.

The Reds - The "carnivores". The carnivores are just a few students with red flags or armbands.

Arrange them in these 3 areas. Then, yell "GO". They have 15 seconds to run and catch a lower trophic level.

If a producer excapes being dinner, he/she remains a producer. If a producer is caught, he/she becomes whatever ate him/her.

If an herbivore is caught, he/she becomes a carnivore. If a herbivore or carnivore do not catch anything, he/she becomes a producer.

After the 15 seconds is up see how the food is distributed. Did the competition deplete any resources? Which trophic level had the hardest time getting food?

CONCEPT:

Competition for food depletes resources

SUBJECT:

Science
P.E.

MATERIALS:

Flags or armbands sorted into colors of green, blue and red.

SQUIRREL COMPETITION

18

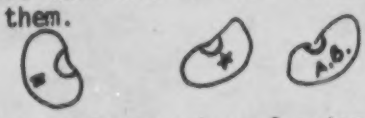
ACTIVITY:

The following is a game to do with your class.

Winter is a tough time for "critters". Some animals store food to help them make it through harsh times.

Red squirrels - hoard their supply in one place.
Grey squirrels - bury their food in many places.
Each will store a supply of nuts and then recover enough nuts to survive the winter.

1. Each student should mark his 10 - 12 beans so that he can recognize them.



2. Mark off an area about ½ the size of a tennis court, in the school yard.

3. Give each student a card stating if he is to be a grey or a red squirrel. (KEEP IDENTITIES SECRET)

4. Be sure to tell students that red squirrels use one storage place for food while grey squirrels use several.

5. It is now fall. For two minutes have students go store their food supply. Reds - all in one place
   Greys - No more than 3 per spot.

6. Winter is 3 "months" (of 2 minutes each) long.

   In December -each must gather 3 of their own nuts. Record how many lived and how many died. The eaten seeds are athrown into paper bag.

   In January - Food becomes harder to find. Squirrels must rely more heavily on their stored nuts. Squirrels must find 4 seeds each. Record survivors / non-survivors

   In February -Food sources are even worse. This time they need 5 seeds, but they can eat anyone's seeds.

WHO LIVED? WHO DIED?

CONCEPT:

Populations are limited by energy available.

SUBJECT:

Science

MATERIALS:

Per student:

10 - 12 Dried lima beans
1 Plastic bag
1 Marker

Group:

Index cards half of which are grey, the others red.
4 Boundary markers
Data Board
1 Paper bag
Marker
Watch with second hand

FOOD CYCLE ENERGY STEPS

19

ACTIVITY:

Make a visual representation of the twelve steps below. (Suggest: color paper tacked on bulletin board so steps can be moved around.)

a. Someone else grows a vegetable.
b. Transports it to a processing plant.
c. It is sliced by machine.
d. It is packaged.
e. It is frozen.
f. Refrigerated truck takes it to market.
g. Market keeps it frozen.
h. You drive to market to buy it.
i. Take home and put in freezer.
j. Thaw it and cook it.
k. Throw away package.
l. Eat it.

Have students discuss any steps which could be eliminated to save energy.

ALTERNATE WAY TO DO THE ABOVE ACTIVITY:
Divide the class into four groups. Give each group one of the four activities to do as a pantomime for the rest of the class. Have class try to guess what each group is trying to show (IT'S IMPORTANT NOT TO SHOW OR DISCUSS ANY OF THE PANTOMIME SKITS UNTIL EACH OF THE FOUR GROUPS HAVE FINISHED)

Group 1 You grow a vegetable
You eat it

Group 2 You grow a vegetabl
You cook it
You eat it

Group 3 Someone grows a vegetable
It's transported to market
They refrigerate it at the market
You drive to the market to buy it
Take it home and cook it
You eat it

Group 4 Someone else grows a vegetable
It's transportated to a processing plant
It's sliced by a machine,packaged,& frozen
Refrigerated truck takes it to market
Market keeps it frozen
You drive to market and buy it
Take it home and put it in the freezer
Thaw it, cook it, throw away the package
Eat it

CONCEPT:
Energy can be saved by eliminating steps in the food chain

SUBJECT:
Home Ec
Science

MATERIALS:
Pencil
Paper
Colored paper

SECTION II: THE FUEL AND THE FLOW . . . WHERE DOES IT GO?

Alternate energy sources provide minimal environmental impact. Building various workable models for students to experience best illustrates the feasibility of alternate energy as a significant contribution to Kentucky's energy picture.

MECHANICAL EQUIVALENT OF HEAT

20

ACTIVITY:

The following is an experiment to do as a class demonstration, in student groups or individually.

Scientists used to believed that heat and mechanical energy were two unrelated concepts. Thus we have units of heat such as calories and BTU's and units of mechanical energy such a joules and foot-pounds. The English physicist J.P.Joule (1818 - 1889), after whom the joule was named, showed that a number of phenomena which had been studied separately until that time were really part of a larger single phenomena --Energy. He also showed how to change units of mechanical energy into equivalent units of heat energy. The following experiment shows students that mechanical energy can be converted into heat and gives an approximate value for the conversion factor between joules and calories.

1.Place a cork in one end of the tube and pour in lead shot to a depth of 5 - 10 cm. Measure the mass of this lead and return it to the tube.

2.Carefully insert the thermometer into the one-hole cork and close up the opposite end of the tube with this cork. Gently tilt the tube so that the lead moves to the thermometer end. Record the temperature of the lead.

3.Remove the cork and thermometer and measure the distance from the top of the lead to the bottom of the top cork. (This is the average distance the lead will fall when you turn the tube over.)

4.Stop up the open end of the tube with the remaining cork. Hold the tube vertically with your hands over both ends of the tube.

5.Quickly flip the tube over and allow the lead to fall to the other end. When the lead hits the bottom, the mechanical energy will be converted into heat, but the change in temperature will be very small. To do a measureable amount of change you must do this about 200 times.

6. When you have finished this step, measure the temperature of the lead again (as in step 2).

CONCEPT:
Energy can be changed from one form to anoth

SUBJECT:

Science

MATERIALS:

Lead shot
Long cardboard tube
Balance
Ruler
3 Corks to fit tube
(2 corks should be solid, one should be one holed)
Thermometer
Meter stick

20

ACTIVITY:

CONCEPT:

SUBJECT:

MATERIALS:

7. Calculations:

Mechanical energy of falling lead :

$E_m = nmgh$

E_m = mechanical energy (in joules)
n = number of falls (200)
m = mass of lead (in kg)
g = acceleration of gravity (9.8 m/S^2
h = distance for one fall (in millimeters)

Heat Energy :

$E_h = m\ c\ \Delta T$

E_h = Heat energy (in calories)
m = Mass of lead (in Kg)
c = specific heat of lead
30.5 cal/(Kg - °C)

ΔT = change in temperature (in C°)

Set-up a ration using the below equation and show that
1 Joule = _____Calories

E_m (Joules) = E_h (calories)

Discussion:

The actual value is 1 Joule = .24 claories. How close did you come? Can you explain your error? How could the experiment be improved?

What change, if any, would occur in the temperature if you had doubled the length of the tube (and hired a long armed gorilla?) doubled the number of turns? doubled the mass? used another metal????

Were any of our measurements unnecessary for our main problem? ($\Delta T = \frac{nmgh}{mc}$)

HOW HOT IS IT?

21

ACTIVITY:

Discuss the concepts of potential and kinetic energy. What kinds of energy can be stored?

Find evidence of stored energy in the classroom and on the school grounds. Store some energy in a most unlikely form.

Have the students prove that there is energy stored
- in a water behind a dam
- in a battery
- in food
- in a fuel such as coal

Have students show how to release stored energy.

Go outside and find a place that is full of energy but is silent.
-Describe how silent energy feels, smells, and looks
-What could make it noisy?
-Make something that has noisy energy
=Make silent energy a part of you and then give it to someone else.

CONCEPT:
Energy comes in different forms

SUBJECT:

Science
Social Studies
Language Arts

MATERIALS:

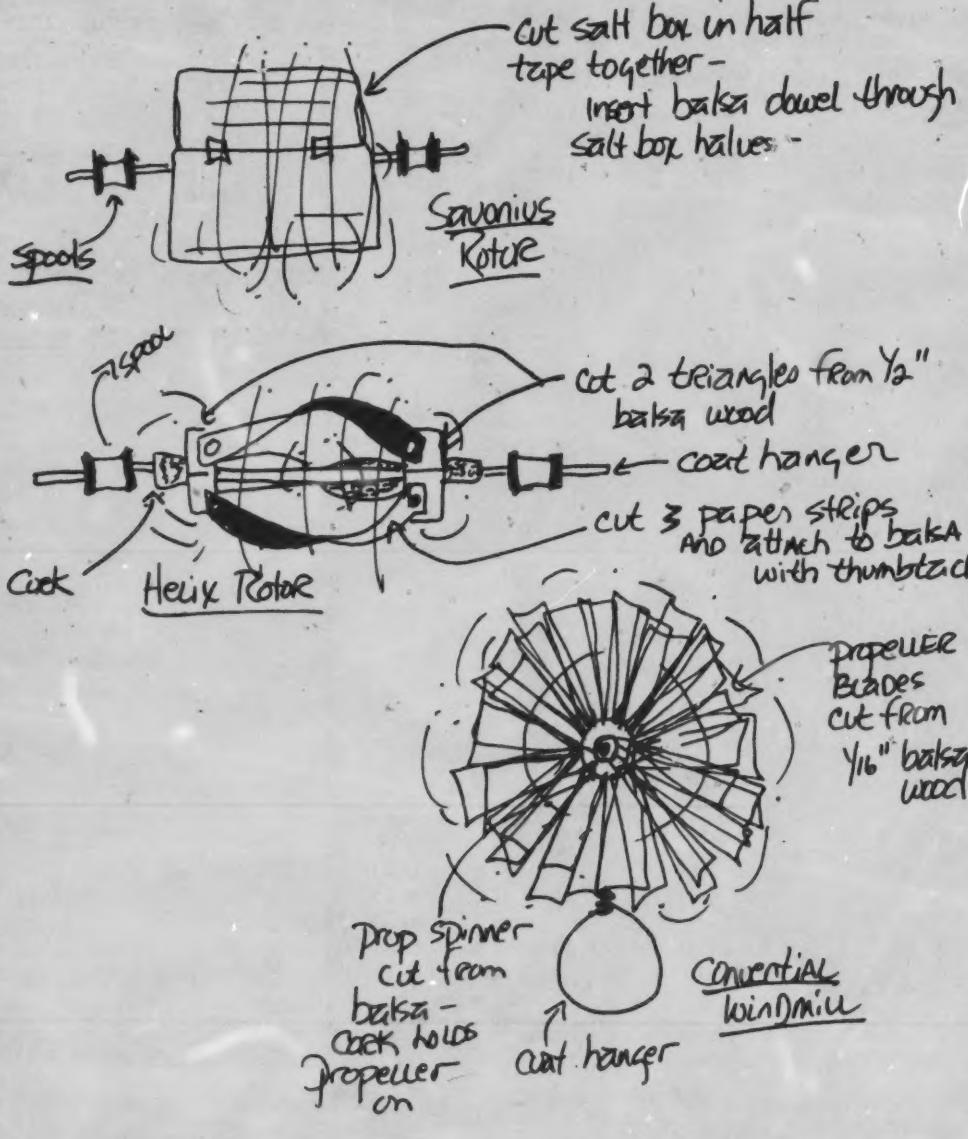
WIND MACHINES

22

ACTIVITY:

Have students find out what the following 3 types of wind machines look like and how they work, they are the Helix Rotor, Savonius Rotor and the Conventional Windmill.

Using various materials available have students try to make workable miniature scale models of the Helix, Savonius and Conventional windmills.


cut salt box in half
tape together -
insert balsa dowel through salt box halves -
spools
Savonius Rotor
spool
cut 2 triangles from 1/2" balsa wood
coat hanger
cut 3 paper strips and attach to balsa with thumbtacks
cork
Helix Rotor
propeller blades cut from 1/16" balsa wood
Prop spinner cut from balsa - cork holds propeller on
coat hanger
Convential windmill

CONCEPT:
To study wind machines as an alternate energy source.

SUBJECT:
Science

MATERIALS:

I'LL HUFF AND I'LL PUFF

23

ACTIVITY:

Do the following activities with students in groups, as a class or individually.

1. Show that moving air has energy
2. Draw a picture of a sailboat in a calm
3. Have students bring in pictures of sailboats under sail.
4. Invent a device that uses the wind to do something useful.
5. Find something being moved by the wind.

CONCEPT:
Wind is an important energy source.

SUBJECT:

Science
Social Studies

MATERIALS:

Paper
Pencils
Drawing materials

SOLAR - GIZE

24

ACTIVITY:

The following are activities to do with students in groups, as a class or individually.

1. Have the students list the direct and indirect uses of solar energy by humans.

2. Determine the availability of each of the sun's present and future uses.

3. Discuss how the sun's energy affects mand and the environment indirectly through:
   a. air
   b. water
   c. soil

4. Have the students find ways that we get energy (heat) directly from the sun --- in the classroom
   --- outdoors.

For further activity:

Write a solar energy "Bill of Rights".
Options: a. Use artforms
b. Use speakers from the community to establish background, impact, etc.

CONCEPT:
Solar energy is our primary energy source

SUBJECT:

Science
Social Studies

MATERIALS:

Pencil
Paper

SOLAR CONSTANT

25

ACTIVITY:

Per student or student groups:

1. Fill the styrafoam cups 2/3's full of water and freeze.
2. Remove cups from freezer and allow to stand until ice heats to 0 C.
3. Pour off excess water, place aluminum disc over top of one cup, and set the cup down with disc perpendicular to sun's rays. (A support may be necessary to prevent tipping.)
4. After 15 minutes, measure the amount of melted water.
5. Do the same with the other cup, except use the opposite side of the disc. (You should start them about 2 minutes apart to enable you to finish the first measurement before the second cup is ready to measure.)
6. The amount of solar energy hitting each disc is S. On the shiny aluminum only 15% of the energy is absorbed. On the black disc, 95% is absorbed. Both cups wil absorb heat from the air in equal amounts. Therfore:

The amount of heat on black disc = Amt. of heat used to melt

$$(0.95)S + \text{Environmental heat} = \left(80 \tfrac{\text{cal.}}{\text{gm}}\right) M_B^{\text{ice}}$$

Amt. of heat on aluminum disc = Amt. of heat used to melt ice

$$(0.15)S + \text{Environmental Heat} = \left(80 \tfrac{\text{cal.}}{\text{gm.}}\right) M_{AL}$$

(where M = mass of ice that melted)

Combining these two equations:

$$0.80S = (80 \text{ cal/gm})(M_B - M_{AL})$$

$$\text{The solar constant} = \frac{S \text{ in calories}}{(\text{area of disc in cm}^2)(15 \text{ min.})}$$

The results on a clear day should be between 1 and 1.3

Use this to determine the size of the collector for various tasks. Remember that no collector will be 100% efficient.

CONCEPT:
The solar constant is a measure of the available power of sunlight

SUBJECT:
Science

MATERIALS:

- 2 Styrafoam cups
- 2 Aluminum discs, same size of cups, one side painted flat black
- 1 20ml graduated cyclinder
- 1 metric ruler
- 1 watch with second hand

SOLAR MODELS

26

ACTIVITY:

The following worksheets are to duplicated for students. Hopefully your class will attempt to make all the models suggested. These worksheets were taken directly from:

CONNECTIONS: A Curriculum in Approriate Technology for the Fifth and Sixth Grades, National Center for Appropriate Technology,1980.

"If You Can't Stand the Heat, Get out of the Collector" was taken from Tuney Kannapell's brain!

"How to Build a Solar Greenhouse" is taken from SCIENCE ACTIVITIES IN ENERGY, DOE, Oak Ridge,1978.
Worksheets to be duplicated for each student are:

"How to Make a Sundial"
"If You Can't Stand the Heat...."
"How to Make a Solar Fruit Dryer"
"How to Make a Solar Cooker"
"How Solar Models Work"
"How to Build a Solar Greenhouse"

CONCEPT:
The sun is our primary energy source

SUBJECT:

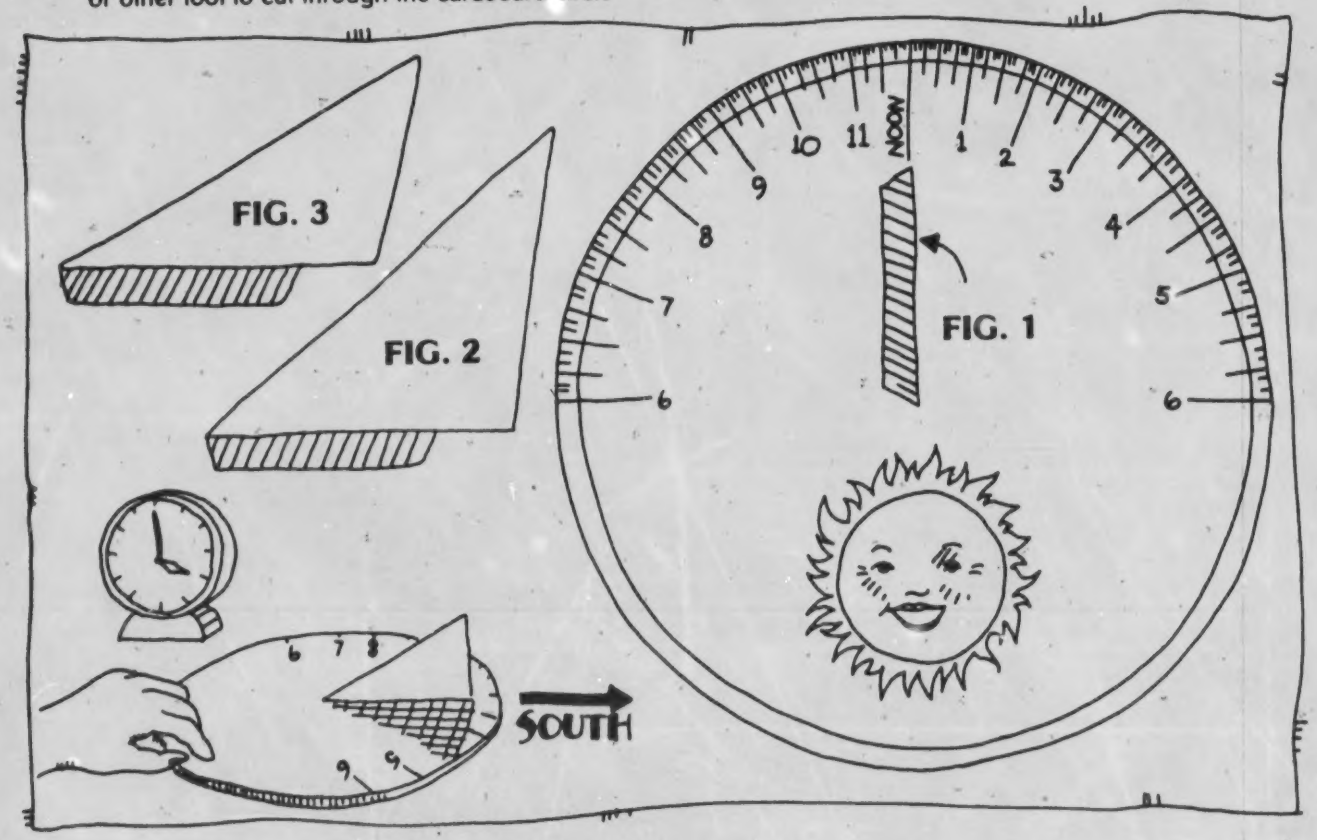
Scienc
Social Studies
Home Ec
Industrial Arts

MATERIALS:

See each individual worksheet.

HOW TO MAKE A SUN DIAL

If you live in the North cut out figures 1 and 2; if you live in the South cut out figures 1 and 3. Use rubber cement to glue the paper figures to a piece of cardboard; cut along the lines through the paper and the cardboard. Use a sharp knife or other tool to cut through the cardboard circle where shown. Insert the base of the triangle (gnomon) through the circle (dial) so it stands at a right angle with the gnomon aligned directly along the noon axis. Bend and glue the gnomon to the back of the dial.



Be sure the dial is kept directly aligned along the noon axis. Otherwise the shadow cast by the gnomon will be off. To determine true North point the sun dial in a northerly direction; look at the time and position the dial so the correct hour shows on the dial. **Remember**: The sun knows no daylight savings time. If you are using an adjusted time frame, base your time of day on standard time and set the dial to North accordingly. Pick a place for the dial that you know will receive sun throughout the day. Be sure your dial is secure and won't be moved by wind, weather or living things. Check the dial at different times of the day to see if it is keeping good time.

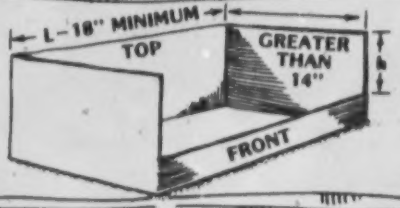
There are a few factors that could throw your sun dial off slightly. We all live in time zones; your location in the zone could effect in a small way the time the sun dial gives you. Also, the angle of your gnomon may not be precisely correct for your latitude. The gnomon cut-outs are angles that reflect the number of degrees of latitude for average U.S. North and South locations. (North: 45 degress; South: 30 degrees). If your latitude varies far from either of these angles you might want to measure another angle that precisely reflects your latitude and cut the gnomon to that size.

HOW TO MAKE A SOLAR COOKER

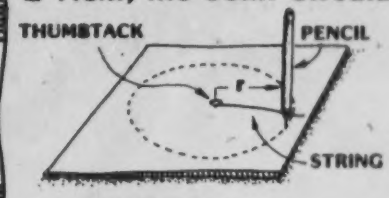
1 Begin with the Frame

You'll need a cardboard box that is strong and in good condition. A long, rectangular box will work better than a short, square one.

Cut the top and front out of the box as shown. The size of this box will determine the size of your cooker.

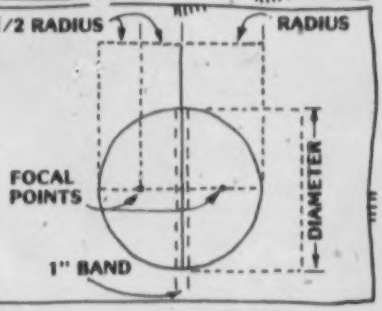


2 Next, the Semi-Circular Ends

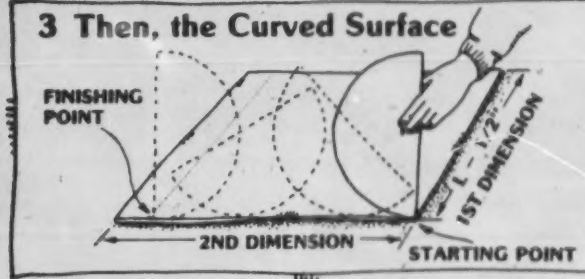


Cut a circle out of cardboard with a radius that is 1" less than the height of the front opening (h) of the frame box.

Locate the focal points as shown and cut out a 1" band, centered along the diameter.



3 Then, the Curved Surface



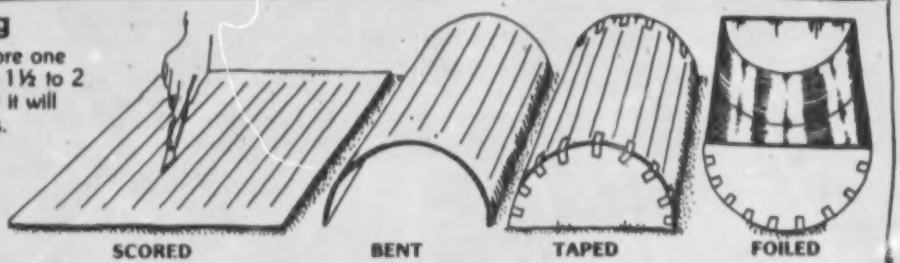
You'll need another piece of cardboard for this part.

The first dimension you need is about 1/2" shorter than the length of the frame (L).

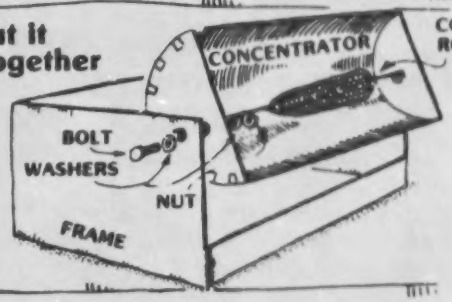
The second dimension is a little more difficult. Start the point of the semi-circular end piece as shown and roll the curved edge along the other unmeasured edge of the cardboard. Be careful not to slip or scoot it. Mark where the other point ends (and maybe add about 1/2"). This distance is your second dimension.

4 Scoring and Taping

After cutting this piece to size, score one side (but don't cut through) every 1½ to 2 inches with lines as shown so that it will bend easily around the end pieces. Tape the end pieces to the curved piece and cover the inside with aluminum foil. Rubber cement works well for this, just be sure to read directions.



5 Put it Together



COOKING ROD

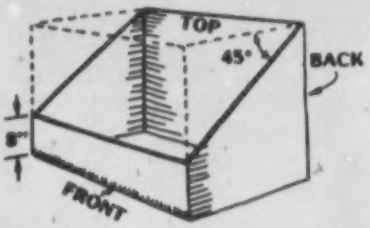
Take an unpainted thick wire and hold over a flame to burn off any excess oily substance, then push wire through the focal points of the curved concentrator to make the cooking rod.

Connect the concentrator to the frame with bolts, nuts and washers as shown.

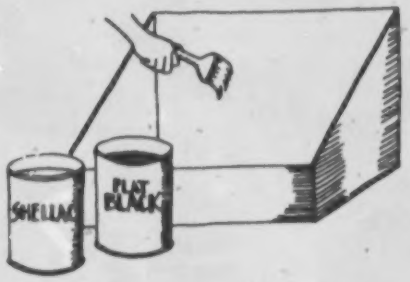
HOW TO MAKE A SOLAR FRUIT DRYER

1 FIND THE RIGHT BOX

Find a box with dimensions that will leave about 8" in front when a 45 degree angle is made from the top corner.



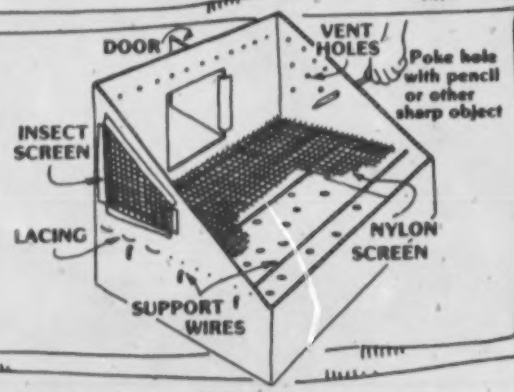
Cut a section out of the box as shown.
The entire inside of the box needs to be black. You can either glue black construction paper to the inside with "Elmers" glue, or you can paint it.
If you choose to paint, first brush on a coat of shellac, let dry for 5-7 hours, then paint with a flat black enamel or latex paint.



2 PREPARE THE BOX

Next, cut a door in the back of the box large enough to let your hand through, plus whatever you will be putting in to dry. Reinforce the uncut, hinging part of the door with a piece of duct tape.

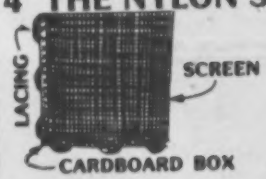
Poke holes in the bottom and sides as shown with a sharp pencil. (about 30 holes).



3

Make 3 or 4 screen support wires out of a thick wire such as a coat hanger wire, and stick them through the box near the bottom as shown and bend down the ends.

4 THE NYLON SCREEN



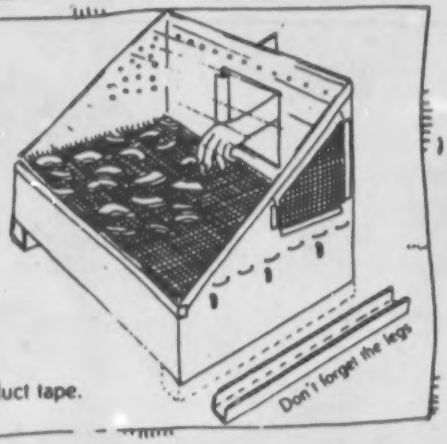
Get some nylon flyscreen material and cut it larger than the bottom of the box, so that the edges can be turned up and laced to the sides of the box.

5 GLAZING THE DRYER BOX

Use "Saran Wrap" or clear vinyl to cover the open top of the box.

Fasten the edges down with silver duct tape.

Make 2 legs out of cardboard and fasten them to the bottom with duct tape as shown.



INSECTS?

If so, cover the vent holes with more of the nylon screen and fasten it with duct tape.

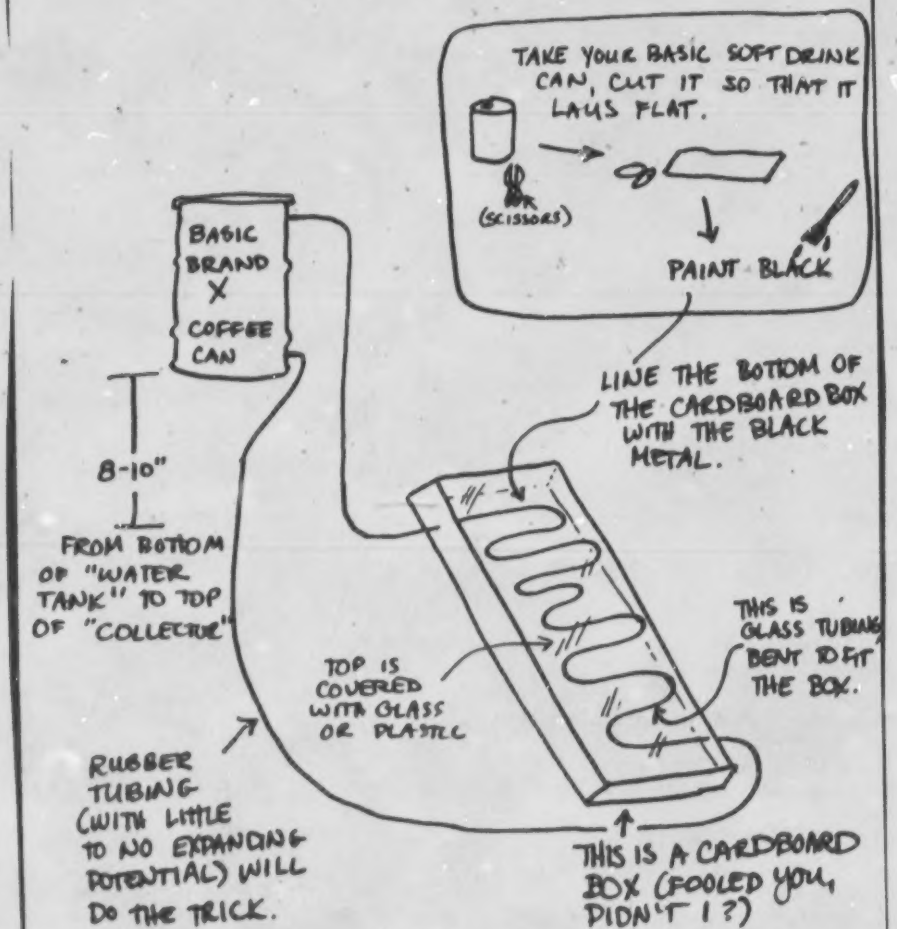
IF YOU CAN'T STAND THE HEAT, GET OUT OF THE COLLECTOR

MATERIALS: COFFEE CAN WITH LID, CARDBOARD BOX, ALUMINUM CAN, GLASS TUBING, PLASTIC OR GLASS FOR GLAZING, BLACK PAINT, PLASTIC TUBING, TIN SNIPS

activity:

MAKE A THERMO-SYPHON WATER HEATER

FOLLOWING THIS DESIGN, YOU WILL BUILD A SOLAR WATER HEATER THAT CIRCULATES UNDER NATURAL LAWS (i.e. USES NO OTHER THAN THE SUN - YIPPEE!).


TAKE YOUR BASIC SOFT DRINK CAN, CUT IT SO THAT IT LAYS FLAT.
(SCISSORS)
PAINT BLACK
BASIC BRAND X COFFEE CAN
LINE THE BOTTOM OF THE CARDBOARD BOX WITH THE BLACK METAL.
8-10"
FROM BOTTOM OF "WATER TANK" TO TOP OF "COLLECTOR"
TOP IS COVERED WITH GLASS OR PLASTIC
THIS IS GLASS TUBING BENT TO FIT THE BOX.
RUBBER TUBING (WITH LITTLE TO NO EXPANDING POTENTIAL) WILL DO THE TRICK.
THIS IS A CARDBOARD BOX (FOOLED YOU, DIDN'T I?)

How much better is a solar greenhouse than a standard greenhouse at keeping a steady temperature in the winter?

Materials

Corrugated cardboard (figure amount needed based on drawings)

Clear plastic, 3- or 4-mil, 50cm x 450cm (local hardware or garden stores)

Flat black spray paint

White spray paint

2 Thermometers

Plastic wrap (grocery store)

Tape

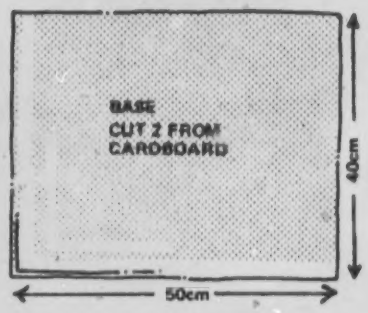
String or thread

Tin cans

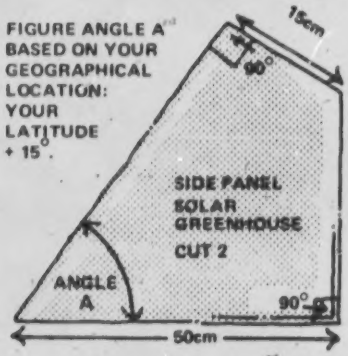
Rubber bands

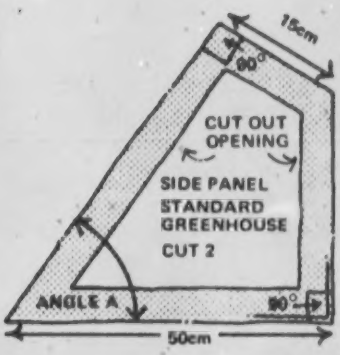
Insulation material (styrofoam, cardboard, newspaper, etc.)

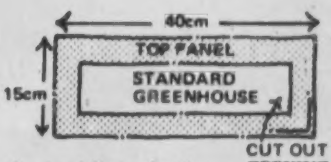
Build a Solar Greenhouse



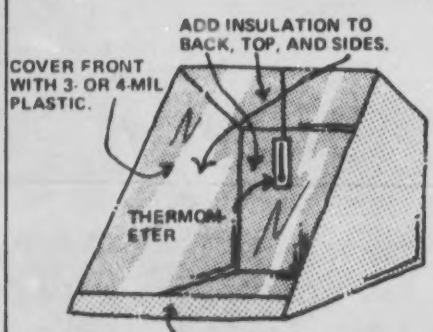
Build a solar greenhouse and a standard greenhouse according to these drawings. (Be sure to cut 2 of each side panel.)







Spray the outside of the greenhouses white before adding plastic.

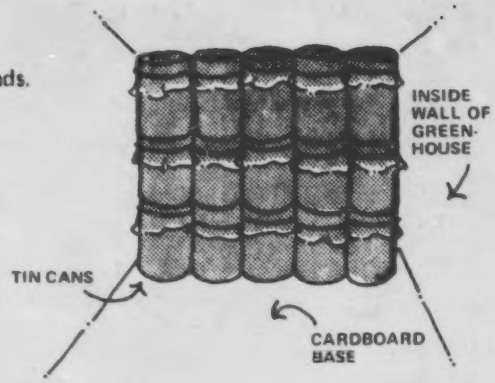


Add 5cm cardboard panel for stability.

Spray the cans flat black.

Fill with H_2O and cover tightly with plastic wrap and rubber bands.

Stack them in the back of the solar greenhouse.

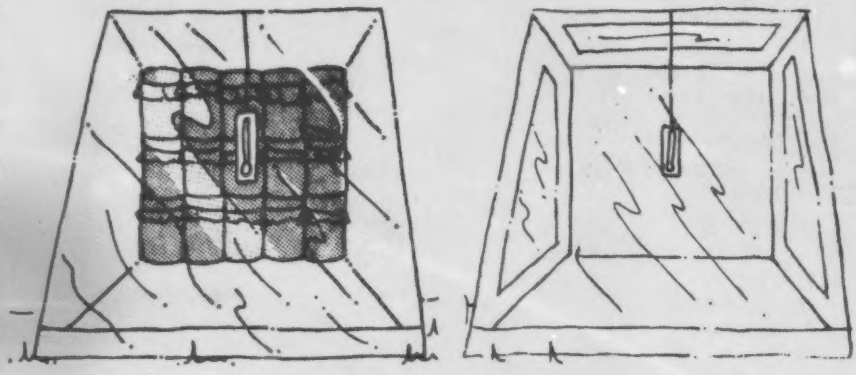


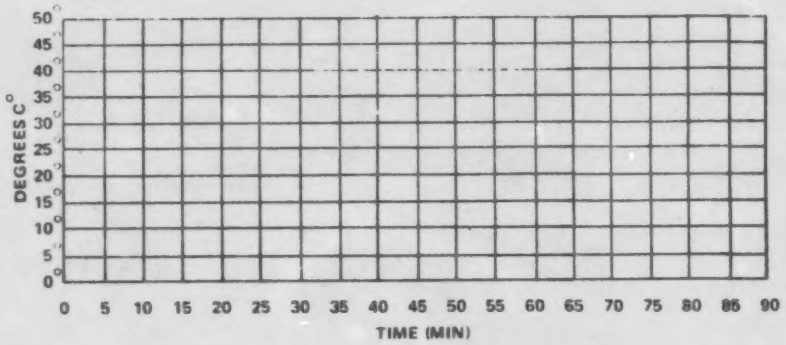
Conduct Your Experiment Like This:

Face both greenhouses directly into the sun.

Measure and record the temperatures in each one as the day progresses.

After they have reached a high temperature place both in the shade—read and record the temperatures as they cool off.





Graph the results of your experiment.

Other Ideas to Explore

What would happen if you added more insulation material? What if you added 2 layers of plastic to the front?

What are other ways of maintaining and storing heat when there is no sunlight?

Try substituting gravel, sand, and soil for H_2O in the tin cans in the solar greenhouse and try the experiment again.

Would you save energy in your climate by using a solar greenhouse?

THE HOT SPOT

27

CONCEPT:
The sun is our primary energy source

SUBJECT:
Art

MATERIALS:
Flat pieces of wood (one per student)

Magnifying glasses

Pencils and Paper

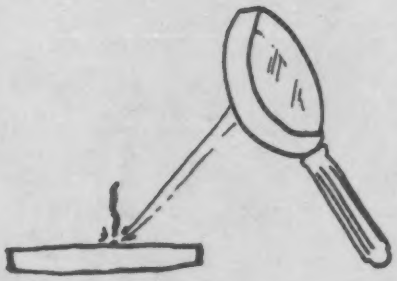
ACTIVITY:

For individual activity:

MAKE A SIMPLE DESIGN.

DRAW THE DESIGN ONTO THE

BURN THE DESIGN ONTO THE WOOD WITH A MAGNIFYING GLASS.



NUCLEAR POWER

28

ACTIVITY:

Have students:

Debate the following statements:
Use of nuclear energy may save the world.
Use of nuclear energy may destroy the world.

Find-out the status of nuclear power plants across the United States. What nuclear plants border Kentucky?

Research information on the types of nuclear power plants which exist.

Define fusion and fission.

CONCEPT:
Nuclear energy is a resource for some areas.

SUBJECT:
Science
Social Studies

MATERIALS:
Research materials

SECTION III: ME AND MY HOMETOWN . . . HOW DO I USE MY ENERGY?

Energy as it can be observed in the immediate surroundings of home and school is explained in terms of the laws of thermodynamics, the characteristics of systems in equilibrium, and the effect of particular kinds of energy on populations. At the community level we deal with local sources of power and local decision-making concerning energy sources. At the global level we deal with energy exchanges, global impacts of local energy decisions, and many ramifications of current and future energy use if trends remain the same.

ENERGY GRAFFITI

29

ACTIVITY:

Post a large sheet of paper (like butcher paper).

Have students list all energy sources.

Have them draw a picture symbolizing each across the paper.

Around each energy source have students draw pictures of or tape magazine pictures of, or list, thins that are good and bad about each energy source.

Post the sheet in some location that will be seen by other students.

CONCEPT:

Exploitation of our energy sources has both positive and negative effects

SUBJECT:

Social Studies
Science

MATERIALS:

Large sheet butcher paper
Marker, pencils,etc.
Magazines

FEELINGS

30

ACTIVITY:

Have students list things about energy that makes them feel:

a. Good
b. Bad
c. Terribly upset
d. Who cares?

Have students use their body (dramatize) to demonstrate:

1. Sunlight
2. Electricity pulsing
3. Coal being mined
4. Oil being spilled or wasted
5. Heat expanding or contracting
6. Light moving
7. Energy changing

CONCEPT:

Exploitation of our energy resources has both positive and negative effects

SUBJECT:

Language Arts
Social Studies
Science

MATERIALS:

ENERGY ATTITUDES

31

ACTIVITY:

Teacher distributes worksheet and reads to students:
On the following worksheet you will see a list of energy activities. These activities require energy for their manufacture, use, and disposal. Check your responses in column "A" with one being the most important to twenty being the least important.

Now that you have ranked these items according to their importance to you, rank the same items on the basis of energy efficiency in column"B".

Now, following discussion, rank these activities in column "C" according to your own priority based on the discussion of columns "A" and "B".

CONCEPT:
Each form of energy can be used in many ways.

SUBJECT:

All areas.

MATERIALS:

WHICH IS THE MOST IMPORTANT?

	A Importance	B Efficiency	C Priority	
1.	_____	_____	_____	Watching TV
2.	_____	_____	_____	Using hot water for bathing
3.	_____	_____	_____	Using electric toothbrush
4.	_____	_____	_____	Using waffle iron
5.	_____	_____	_____	Reading a book
6.	_____	_____	_____	Eating a raw apple
7.	_____	_____	_____	Cooking a TV dinner
8.	_____	_____	_____	Riding car to store
9.	_____	_____	_____	Driving to a movie
10.	_____	_____	_____	Making homemade ice cream
11.	_____	_____	_____	Applying lipstick or cologne
12.	_____	_____	_____	Shaving with electric razor
13.	_____	_____	_____	Spraying aerosol deodorant
14.	_____	_____	_____	Using electric hairdryer
15.	_____	_____	_____	Riding a bicycle
16.	_____	_____	_____	Taking a walk in the sun
17.	_____	_____	_____	Eating a candy bar
18.	_____	_____	_____	Attending a night football game
19.	_____	_____	_____	Eating a hot school lunch
20.	_____	_____	_____	Riding a school bus

WHOSE RIGHTS ARE RIGHT?

32

ACTIVITY:

Students are arranged into groups of four. Each student is given a copy of the case study and several related questions. As a group they are to discuss the problems involved and try to come to a group decision.

CASE STUDY

Area: Along the Ohio River, in an area called the Big Bend

Location: A 350 acre farm

History: The psople living in the area are direct descendents from the original owner, a Southern plantation master. The area was once a thriving plantation located along the banks of the river. Today, a single woman resides on the farm in question. She is the granddaughter of the original owner. The current owner cares little for the farming way of life, but has a religious reverence for the land of her forefathers. Recently, she learned that less than 400 feet down on her land there is a four-foot seam of coal. In addition, natural gas has been found on her farm. She has agreed to allow the gas to be pumped out but no gas has been removed to date. Not only that, but various individuals in the gas company have reputedly asked for secrecy concerning her wells.

Beyond this, a large electric company is considering buying her farm as a site for a nuclear power plant. In attempting to purchase the farm, the electric company reputedly claimed no knowledge of the coal seam. Currently the owner does not want to sell. If she refuses, the state will condemn her land, buy it and sell it to the power company.

Questions:

Does an individual have the right to refuse to sell his/her land? Does a power company have a responsibility to be completely frank with potential land purchases? Should land be used for "national need" as opposed to "personal need"? If you were a power company president, would you take the ancestral home from a 75 year old widow? Should a power company own land which it does not intend to build a plant on?

CONCEPT:
Exploitation of our energy resources has both positive and negative effects.

SUBJECT:

All areas

MATERIALS:

ENERGY SONGS

33

ACTIVITY:

With the help of your students, prepare a tape of songs related to energy and the environment.(See suggestions at the end of activity). Play the completed tapes;putting the lyrics on the overhead may facilitate discussion.

Have sutdents look up any terms or concepts with which they are unfamiliar.

Discuss the viewpoint of the artist and the quality of the evidence given.

Look for conflicting opinions, emotional words, and ambiguous phrases.

Discuss how effective the students rate each song. Why do they feel it was or wasn't effective with them? Might there be other groups who would feel the opposite?

Ask students to list songs about other issues. Are protest songs as common as in the past?

Encourage students to write their own energy/environment songs.

Some suggested songs and artists for starters:

Nuclear energy: Musicians United for Safe Energy, No Nukes album, Dan Fogelberg, Phoenix , "Face the Fire"

Coal: Billy Edd Wheeler, musician and ballad writer
John Prine, "Paradise"
Various traditional folk tunes like "Sixteen tons", "Dark as a Dungeon"

Assorted: Buffy St. Marie, Pete Seeger, Judy Collins, Phil Ochs, Joan Baez, Melvena Reynolds, Johnny Cash, Burl Ives, Jim Croce, John Denver, Gordon Lightfoot, Arlo Guthrie, Woodie Guthrie, Jack Elliot, the Limelighter, etc.

CONCEPT:
Media is used to influence opinions on issues.

SUBJECT:

Language Arts
Social Studies

MATERIALS:

Tape player
Tapes, records, songsheets.

SHORTAGE!

34

ACTIVITY:

Assign the following roles (and others you may think of): Govenor of Kentucky, Mayor, 9 mos. pregnant women, director of city hospital, police chief, owner of a small family business, farmer, school superintendent, teenager, etc.

Using role playing, students should act out their respective roles in light of one of the following crisises:

- *gasoline shortage
- *week long power (electricity) shortage
- *water shortage
- *nuclear power plant accident

After the role playing exercise, discuss with students why they acted the way they did How else could or should they have acted?

CONCEPT:
Energy is costly and our lifestyle is affected by its accessiblity

SUBJECT:

Social Studies
Science

MATERIALS:

ENERGY NEEDS

35

ACTIVITY:

Have students:

1. Make a list of their personal energy needs. Cross-out anything that is not necessary for survival

2. Describe their family's energy needs. How does each students compare to others and their familys' needs?

3. List the energy needs that are not necessary and have students try to do without them for 24 hours.

CONCEPT:
People use energy for basic needs and desires

SUBJECT:

All areas

MATERIALS:

Pencil & Paper

"METER READERS"

36

ACTIVITY:

Your local utility company has various brochures available for class distribution on ways to read your electric meter as well as information of ways to save electricity.

Obtain literature on meter reading and distribute it to your students. Have them calculate the amount of electricity your school uses in 1 hour . . . 1 day. . . 1 week. . . etc.

Check with your utility company on the current cost of operation for Kwh. See Activity 6 "Measurement of Energy"

CONCEPT:
To aquaint students with methods for reading utility bills & the electric meter.

SUBJECT:
Math
Science
Social Studies

MATERIALS:

ENERGY RESOURCES IN KENTUCKY

37

ACTIVITY:

Using the worksheets which follows have students locate their city and also the following communities: Frankfort, Louisville, Lexington, Paducah, Owensboro, Morehead, Madisonville, Hazard, and Ashland.

Have students design their own key (a symbol for each energy resource) and plot the energy resources of Kentucky.
Discuss the following questions:
What is Kentucky's most abundant resource?

Could Kentucky be energy independent? If yes, how? If no, why not?

Does it appear that Ky. needs to import any energy resources?

CONCEPT:
Energy resources are in our state.

SUBJECT:

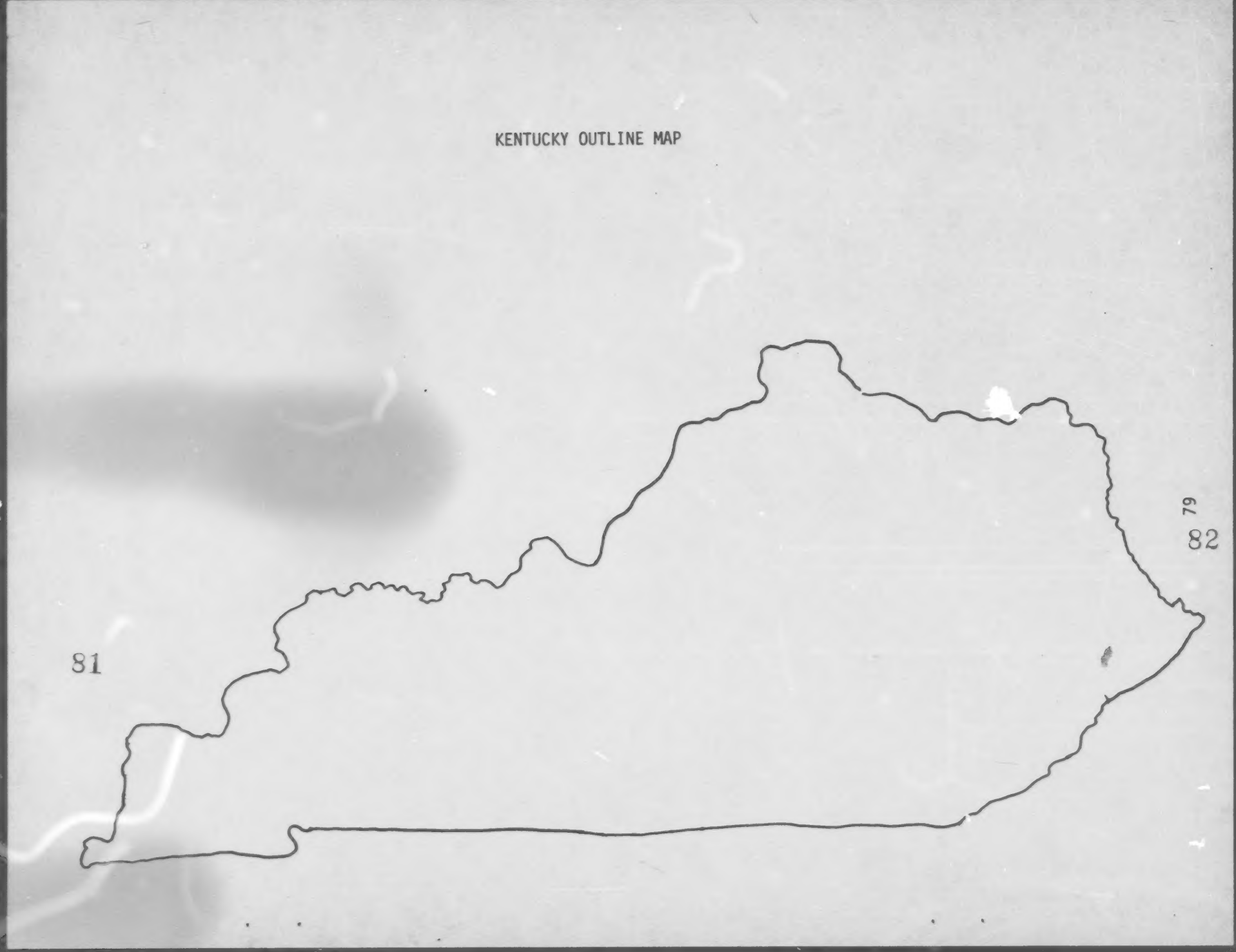
Social Studies
Science

MATERIALS:

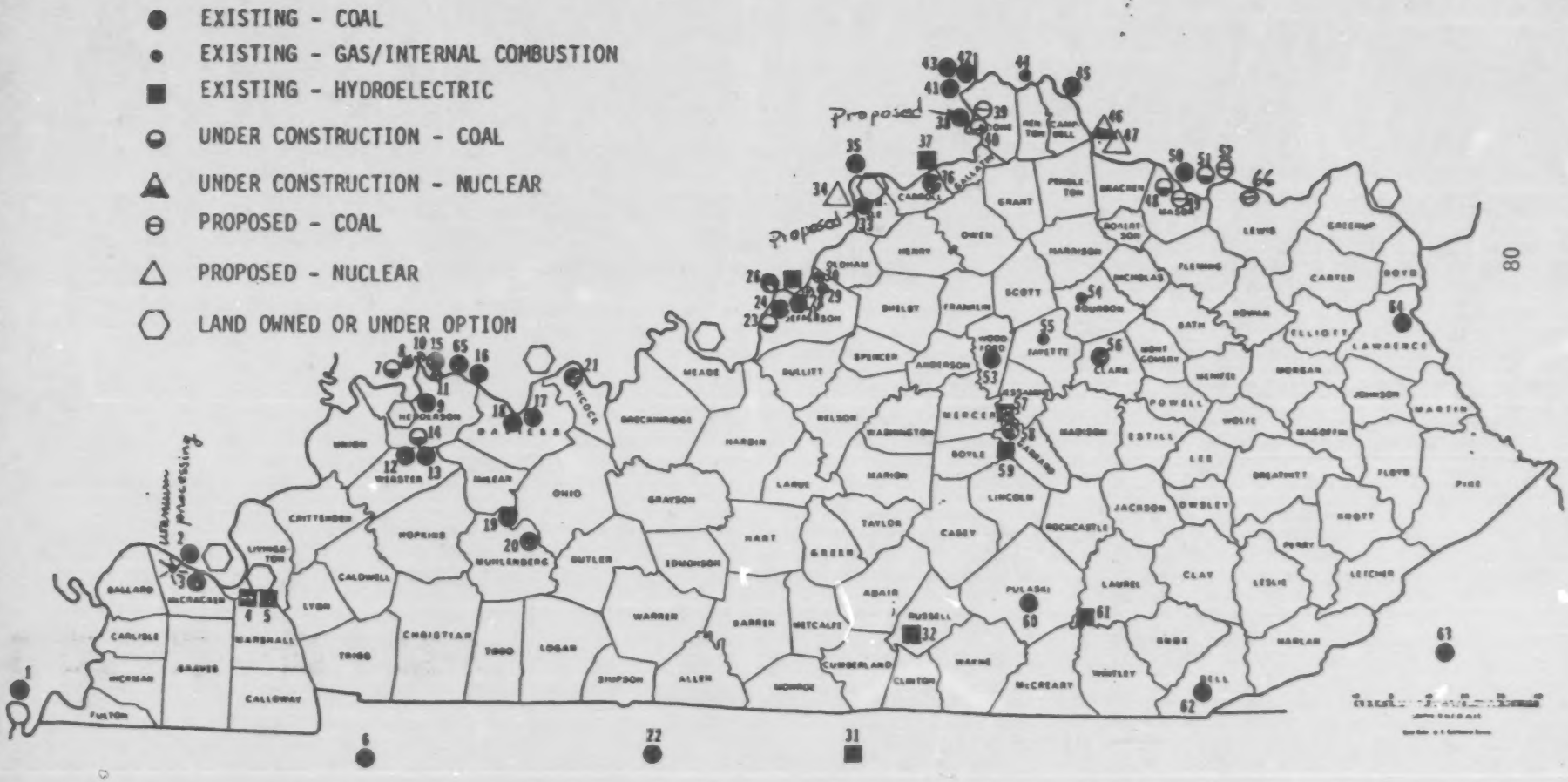
The following worksheet

Outline of Ky.
Electric Power Plants
Coalfields of Ky.

KENTUCKY OUTLINE MAP



ELECTRIC POWER PLANTS



Prepared by
Division of Air Pollution Control
Bureau of Environmental Protection
Kentucky Department for Natural Resources &
Environmental Protection

U.S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE, LEXINGTON KENTUCKY

• RURAL ABANDONED MINE PROGRAM COUNTIES

KENTUCKY

APPROXIMATE SCALE MILES

81

86

THE GOOD 'OLE DAYS

38

ACTIVITY:

Using the "Good 'Ole Days" worksheet have each student interview someone in their community who is old enough to remember what life was like before the days of intensive energy use. Ask him or her the questions on the worksheet as well as adding some other ones.

CONCEPT:

People tend to waste available energy source: on nonessential items

SUBJECT:

Social Studies
Language Arts

MATERIALS:

Per student:

"Good Ole Days workshe

THE GOOD OLD DAYS?

Interview someone who is old enough to remember what life was like before the days of the great usage of oil and natural gas. Ask him or her the questions that follow and others that you think of yourself.

1. What kind of lights did you use in your home?
2. How was your home heated?
3. What sort of washing machine did you have?
4. What kind of stove did your family use for cooking?
5. Did you have a refrigerator? How did you keep your food fresh?
6. How was food packaged when it came from the store? What did milk come in?
7. What sort of soap did you use? Did it clean as well as the cleaners we have now?
8. How was your water heated for bathing and laundry?
9. Did your family have a car? If not how did you travel?
10. Did you have a television? A radio?
11. What kinds of entertainment did you enjoy?
12. In what ways is life for you more enjoyable now that we have electricity, plastics, detergents, and other oil and natural gas products?
13. In what ways did you like the "good old days" better than today?
14. If you could choose what period of history would you like to live in (including present and future)?

ENERGY IN THE NEWS

39

ACTIVITY:

As a class activity:

For one week, keep a record of energy articles that appear in your newspaper. These articles should pertain to energy activities in your local community and state.

*Find an old newspaper or go to a newspaper office and compare the number and types of energy articles with the same week a year ago -- and ten years ago.

*Discuss what energy issues and problems were important 1 year ago --- and 10 years ago. Are these issues and problems still important today? What energy issues and problems are likely to be important in your community and state 1 year from now? 10 years from now?

*Have the students write an article for the newspaper about what they're doing to conserve energy.

CONCEPT:
Energy resources now available are in limite supply

SUBJECT:

Language Arts
Social Studies

MATERIALS:

Newspapers from various time frames

HOW MANY MILES PER GALLON?

40

ACTIVITY:

As a homework assignments students will:
Choose a service station which will convenient to use for two fill-ups. Choose the same pump to use each time and make sure your car is level.

Get a fill-up: make sure the tank is filled to the top. Record the mileage on the speedometer.

When the gas tank is at least below half full, go back to the same place and under the same circumstances, fill the gas tank.

Record the mileage and the amount of gas used in gallons. Find the difference in mileage and divide by the number of gallons purchased in the second fill-up.

List as many variables as you can that might affect the mileage of your car. Example: in town driving vs. driving on a trip, rapid acceleration bs. smooth take off, car before tune-up vs. car after tune-up.

CONCEPT:

There are many ways to conserve energy.

SUBJECT:

Math

MATERIALS:

Home work assignment, see instructions

GAS RATIONING

41

ACTIVITY:

During the energy shortage, many salesmen, whose livelihoods depend upon automobiles, were upset to see teenagers wasting fuel by cruising, squealing tires, etc. Some of them suggested that the driving age be raised to eighteen.
Discussion questions:

Do you feel that the salesmen have a valid complaint?

How do you feel about the proposed solution ?

If such a law were passed, how would it change your lifestyle?

Form a mock congressional subcommittee to draw up a plan for fuel rationing. Include testimony by students playing the roles of a farmer, a trucker, a salesman, a homeowner, a fisherman, an airline executive, etc.,each stating to the committee why his/her area should not be reduced. Try to draw up an equitable plan.

Have students interview people who remember rationing efforts in the United States during World War II. What were the restrictions at the time for using gasoline? How did people recieve their gas rationing tickets?

CONCEPT:

Some human technologies use more energy than others.

SUBJECT:

Social Studies
Language Arts
Driver's Ed.

MATERIALS:

None

CAR SURVEY

42

ACTIVITY:

Have students go outside and write down all the different types of cars they can find in the school parking lot. If possible have them list : make of car, year it was built, and apparent condition.

After students have completed the list have them find out the estimated miles per gallon of each make of car they have down on their list. (Use a consumers guide from your library).

Let students make a large display of their findings and determine if their school is energy "conscious" or not.

Note:
Discuss the various factors which might keep some people from buying automobiles according to their gas rating. These would include:
*car safety
*number people in household
*affordability of being able to purchase a new car

CONCEPT:
There are many ways to conserve energy.

SUBJECT:

Social Studies
Math

MATERIALS:

Library
Pencil
Paper

THE OIL-Y BIRD CAN'T CATCH A WORM

43

ACTIVITY:

Background information:

The oil in sewage and in rivers is the #2 polluter of all oil use! The major component of oil in sewage and rivers is CRANKCASE OIL from your car!

Action:

You can help clear up this problem since most people who drive cars have some control over changing the oil in their cars.

Make a public service announcement, a display or a videotape on recycling your waste oil. (Catch the oil in a pan, take it to a local gas station - not all will accept it, but many are used oil recyclers)

In your announcement:

*Give directions of recycling stations
*Let your audience know how important this is!

CONCEPT:

There are ways to conserve energy.

SUBJECT:

Science
Social Studies

MATERIALS:

Materials for displays and announcements

ENERGY FLOW

44

ACTIVITY:

Each student should select an item they recently purchased and using a large roll of butcher paper draw the various steps it took to make that item from its original raw state. Be sure to have student to include in their drawings the following:

*all raw materials used in the process
*the various methods of transportation that were used in delivering the item into the hands of the student
*the various fuels used in manufacturing the product
*the types of packaging material it took to produce the final product
*list of various materials and steps and energy it took to produce the packaging material for the item.

CONCEPT:
Energy is used to produce all manufactured items

SUBJECT:

Social Studies
Science

MATERIALS:

Butcher paper
Drawing materials
Reference material from the library

IT'S A RAW DEAL

45

ACTIVITY:

Have the class visit a sewage treatment plant. Explore the answers for the following questions:

1. Is the waste treatment plant primary?
2. Is the waste treatment plant secondary?
3. Is the waste tteatment plant tertiary?
4. Do industries dump wastes into the community treatment plant?
5. Do industries dump untreated wastes into local water sources?
6. Do homeowners dump untreated wastes into local water sources?
7. Is some waste bypassed into local water sources during normal dry weather? a. what percent? b. how often?
8. In wet weather, when lines and plants may be filled by storm flow, is some sewage bypassed into local water sources? a. what percent b. how often?
9. Does the waste treatment plant have enough employees to operate it efficiently on a 24 hour basis?
10. Does the water treatment plant have enough employees to operate it on a 365 day basis?
11. Is the treatment plant up to date?
12. Does the community require connection to a public waste treatment plant? How many sewer pipes are not connected to a waste treatment plant?
13. Does the community prohibit its sewer system from being connected with storm water drains?
14. Does the community have a sewage treatment problem?

CONCEPT:
Cleaning up our environment is the most energy efficient conservation method for future & present generations

SUBJECT:

Science
Social Studies

MATERIALS:

Pencil
Trip to a sewage plant

Field Trip to a Power Plant

46

ACTIVITY:

Have the class visit a power plant. Explore the answers and problems below:

1. Tour the power generating plant that supplies your city. Determine whether this is the best site on the basis of power source, transmission line length, impact on the immediate environment, impact on the city's environment.

2. It is not always possible to construct an electrical energy producing power plant in the most desirable location. Suppose your geographic area needed more electric energy. Establish a set of criteria that might be used in studying where to locate a plant.

3. Identify and discuss the environmental trade-offs which make possible off-shore drilling.

4. Assume that it costs about 20% more to build a dam with locks which would allow for shipping purposes. Assume also that an ideal dam site has been developed, but the citizens are opposed to the increased costs. How could you defend or oppose the building of locks in the dam?

5. Identify the government agencies in your state responsible for providing permits to build an electrical generating station. Obtain a copy of their regulations and evaluate the merits of each rule.

Taken from: Energy and Man's Environment, Inc., Washington State Department of Public Instruction, 1976.

CONCEPT:
The use or non-use of any energy source requires environmental trade-offs.

SUBJECT:

Social Studies
Science

MATERIALS:

WHO PAY'S THE PRICE?

47

ACTIVITY:

Have students discuss and do the following questions and problems:

1. Compare the environmental impact of surface and deep mining of coal. Visit sites if possible and ask for a tour of an area that has been "reclaimed".

2. List three ways a mining area may be restored following the mining operation.

3. Surface mined coal in the eastern and western United States differs in sulfur content. The higher sulfur eastern coal results in mine acids (sulfuric acid) that make the land difficult to reclaim by vegetation planting. Western coal mining operations are usually in arid regions with a delicate terrestrial ecosystem. Compare the types of vegetation used in reclaiming the land. Compare the difficulties of reclaiming the land.

4. Write three coal companies requesting information on the various methods they use for reclaiming the land. Compare the methods used and note differences in methods for various types of geological areas.

5. List three energy industries and/or government agencies. Contact each one asking for sample copies of their environmental impact statements. Compare the impact statements noting common areas of discussion. Then note differences in the various impact statements. List major items you believe should be covered by the individual imapct statements. Write a letter to each of those organizations involved providing your recommendations and ask the organization for a reply.

6. Write a public interest group for information on regional effects of coal mining.

7. Contact a legal services firm (Appalachian - Research Defense Fund) to find out what kinds of environmental cases they have been handling and who they are representing.

8. Consult the land ownership study of the Appalachian Alliance to find out who owns the land in the coal mining regions in Kentucky (another excellent source is the Kentucky Coal Journal, Frankfort, Ky. 40601)

CONCEPT:

Energy extraction alters original environmental conditio

SUBJECT:

Social Studies
Language Arts
Science

MATERIALS:

Reference and researc materials
Pencils

47

ACTIVITY:

9. Evaluate coal mining regions in terms of road conditions, tax revenues, water quality, recreational resources, erosion, frequency of flooding, local drought, and/or other ramifications of mining.

10. Write to several coal companies and ask them where they ship their coal. Make a map showing the transportation of coal from Kentucky to its destination.

CONCEPT:

SUBJECT:

MATERIALS:

HOW FAR SHOULD WE GO?

48

ACTIVITY:

Have the class brain storm opposite positions on issues related to personal resposibilities to others; examples could include

I have the right to eat, what I want and as much as I want.	I must make every decision as to what I eat in the light of global hunger.
The U.S.A. is only responsible to U.S. citizens.	The U.S.A. must distribute its' food equally to all hungry people in the world.
The U.S.A should discontinue immigration totally.	The U.S.A. should accept anyone from anywhere.
The U.S.A. should stop all foreign aid.	The U.S.A. should distribute its' wealth to everyone worldwide.

Using the side of the room, the hall, or some other line to represent the spectrum of opinions on one issue, students are to line themselves up according to their own opinion. Students determine their relative positions by conservation with each other.

After discussion concerning the above issues have students draw-up a list of 100 things individuals can do to help stop world hunger. Be sure to emphasize the huge amount of energy costs related to transporting various food items. Refer back to "How Far Does Your Breakfast Travel" activity.

CONCEPT:
The energy crisis is a global problem.

SUBJECT:

MATERIALS:

WHEN THERE IS NOT ENOUGH

49

ACTIVITY:

As a class activity:

Nations have gone to war to protect or to gain energy resources. Find-out what energy resources people fought for in wars involving the United States. These might include: the Revolutionary War, Civil War, World War I and II, Spanish-American War, etc.

Study the list of countries below that the United States is dependent on for essential resources. What kind of relationships does our government presently have with these countries?

U.S. Import Dependence for 12 Key Raw Materials

Raw Material	Percentage Imported 1950	1975	1985	2000	Major sources of World Reserves in the Year 2000
Chronimum	99	91	100	100	USSR, S.Africa, Turkey
Tin	77	75	100	100	Malaysia, Bolivia Thailand
Manganese	85	98	100	100	USSR, S.Africa, Brazil
Nickel	94	71	88	89	Canada, New Caledonia, USSR, Cuba
Aluminum (Bauxite ore)	40	85	96	98	Jamaica, Surinam, Australia
Zinc	38	64	72	84	Canada, Mexico, Peru
Tungsten	40	54	65	93	China, Canada, Peru
Lead	39	21	62	67	Australia, USSR, Canada, Mexico
Iron Ore	8	29	55	67	Brazil, USSR, India Canada
Potassium	14	49	47	81	Canada, Germany
Copper	31	18	45	75	Chile, USSR, India Canada
Sulfur	2	0	28	52	Canada, Mexico

Sources: Cameron 1973, Chourci 1972, Kahn et al. 1976 National Commission on Material Policy 1973, Wade 1974c.

CONCEPT:

The energy crisis is a global problem

SUBJECT:

Social Studies
Science

MATERIALS:

Reference materials
Library

ENERGY USE AROUND THE WORLD

50

ACTIVITY:

Divide class into groups of 3 and have them pick a country from around the world.

Through library work gorups investigate housing in the city and the country. Figure out energy needs of the average household and how they are met.

Do the same for transportation, agriculture and food.

In class discussion:

Does your country import?

What does your country export?

Does your country use more energy that the United States?

CONCEPT:
The energy crisis is a global problem

SUBJECT:
Social Studies

MATERIALS:
Reference materials

FOOD AND THE LIFEBOAT ETHIC

51

ACTIVITY:

The purpose of the activity is to have students feel the pressures and responsibilities of those countries possessing resources by role-playing a situation where they are requested to help countries which do not have the resources .

Procedure:

1. Assign students to collect visual examples of starvation and depreivation. Put the examples on the walls. Create an audio-visual mood appropriate to the esperience, e.g. the lifeboat theory includes pictures of over-indulgence.

2. Considering your own resources, design a space in the classroom that is somewhat inaccessible to the larger number of students, probably in front of the class. Have two or three students enter the "comfortable space" and sit detached from the larger group.

3. The "have nots" should be arranged in a crowded and uncomfortable fashion around the "lifeboat". Their mobility is limited so that they cannot get into the "boat."

4. The "haves" possess food resources that must be divided with anyone who "bargains" their way into the lifeboat. The "have nots" may, in return for access, give something. At some point the lifeboat space and resources will be reduced to where the "haves" are approaching a "have not" status.

5. Discuss the implications of using other countries' resources, as well as sharing your own.

6. Questions you may wish to consider: 1)Do the "haves" sell the right to come aboard or will they accept credit? 2)Is this a valid analogy to the worl population and food crisis? If not, improve upon it. 3) Does the U.S. have a policy now concerning the needs of countries poor in resources? 4)What could happen if the "haves" changed their food production and consumption habits?

Taken from: Energy, Food, and You, State of Washington Department of Public Instruction, 1978.

CONCEPT:
The energy crisis is a global problem

SUBJECT:
Social Studies

MATERIALS:
None

IS THERE AND ENERGY CRISIS ON SIGMA DRACONIS IV?

52

ACTIVITY:

Drake's Equation is an attempt to estimate the number of technological societies in our galaxy. It is based on estimates of the number of planets per star, the number of stars, how many of these have life, etc. These are all estimates, so when going through this equation encourage the class to provide its own estimate before giving the opinion of the "experts". Sources of background information which should be studied by the teacher beforehand are:

We Are Not Alone, Walter Sullivan, McGraw-Hill, 1964.
or
Cosmos, Carl Sagan, Random House, 1980.

The most important factor in the equation below if the L factor, "How long can we survive?" Use this equation as a jumping off point to discuss the serious problems facing our Earth. (Such as world hunger, resource depletion, etc)

THE PROBABILITY OF EXTRATERRESTRIAL INTELLIGENCE IN OUR GALAXY - DRAKE'S EQUATION

$$N = R_* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L$$

N = the number of civilizations capable of communicating with other solar systems

R_* = the rate at which stars were being formed in the galaxy during the period when the solar system itself was formed

f_p = the fraction of stars with planets

n_e = the number of planets, per solar system, with an environment suitable for life

f_l = the fraction of suitable planets on which life actually appears

f_i = the fraction of life-bearing planets on which intelligence actually appears

f_c = the fraction of intelligent societies that develop the ability and desire to communicate with other worlds

L = the longevity of each technology in the communicative state

CONCEPT:
The consumption of available resources can have serious effects for world survival

SUBJECT:
Social Studies
Science

MATERIALS:
Pencil and Paper

52

ACTIVITY:

CONCEPT:

SUBJECT:

MATERIALS:

Estimates by Participants at the Green Bank Conference on Extraterrestrial Life

	High Estimates	Low Estimates
R_*	10 per year	1 per year
f_p	1 out of 2	1 out of 5
n_e	5	1
f_l	1	1
f_i	1	1
f_c	1 out of 5	1 out of 10
L	few hundred million yrs.	few hundred thousand yrs
N	10^9	10^4

EFFECT OF L ON COMMUNICATING WITH ALIEN CIVILIZATIONS estimated by Dr. A.G.W.Cameron (lecture given at Ohio University, January 27, 1972)

If L = 1,000 years, average distance between civilizations would be 1000 light year;communication would be rare or impossible (Would take 2000 years to get an answer)

If L = 1 million years, average distance between civilizations would be 100 light years -- Communication Possible!

If L = 1 billion years, average distance between civilizations would be 10 light years --We should be able to pick up signals from another earth-like civilization at this distance with present equipment.

SECTION IV: USES AND ABUSES OF OUR ENERGY RESOURCES . . . WASTE NOT, WANT NOT

It is important to realize that individual choices regarding lifestyle selections has immediate impact on the environment. Every selection of food, clothing, and shelter we make requires energy --- some selections are more costly to our energy resources than others.

These selections in turn are also costly to other individuals, as the world becomes a smaller place with less resources to share.

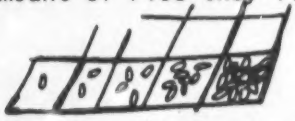
and it greW, and it GREW, and IT GREW, AND IT GREW.....

53

ACTIVITY:

Give each student a checkerboard (see following worksheet) and a handful of rice.

Tell them to place one grain of rice in the lower left hand square, two grains in the next square, four in the next, eight in the next, 16 in the next and continue this pattern. Have students estimate the amount of rice they'll need.



When students realize they have run out of room, and are faced with an impossible task, discuss these questions:

1. Were you able to fill all the squares?
2. How is the doubling or rice grains in the squares like our current consumption of energy?
3. What will happen if we continue to consume energy at our present rate of consumption?

CONCEPT:
Populations are limited by the availabl energy.

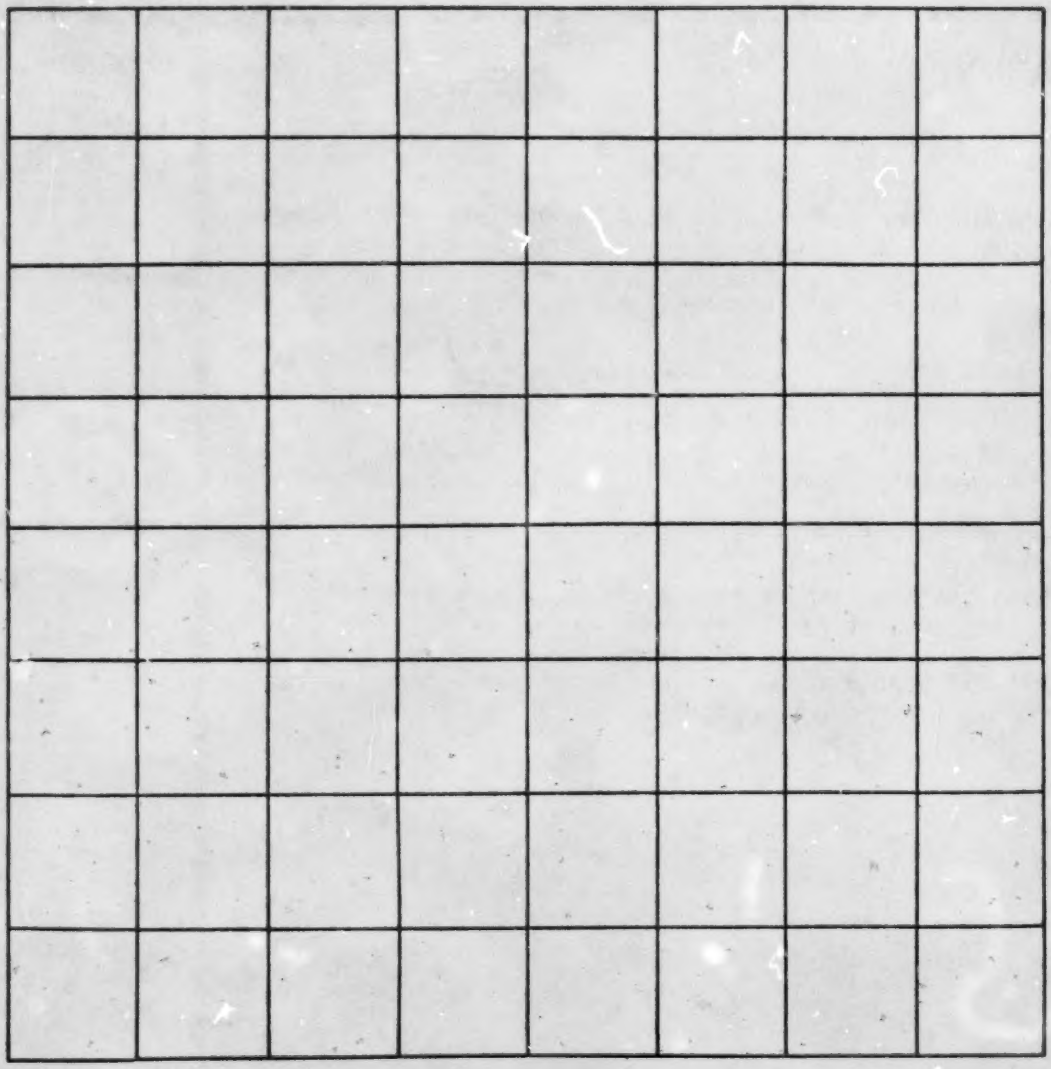
SUBJECT:

Social Studies
Science

MATERIALS:

Checkerboard per student
5 pounds of rice

RICE CHECKERBOARD

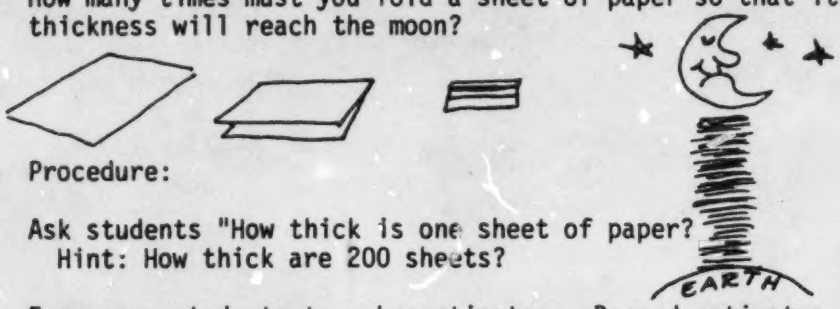


STAIRWAY TO HEAVEN

54

ACTIVITY:

How many times must you fold a sheet of paper so that its thickness will reach the moon?



Procedure:

Ask students "How thick is one sheet of paper?
Hint: How thick are 200 sheets?

Encourage students to make estimates. Record estimates to see who comes closest and how close!

Sample Calculations

1 sheet = .005 inches
First fold = .01 inches
2nd " = .02 "
3rd " = .04 "
4th " = .08 "
5th = .16 "
6th " = .32 "
7th " = .64
8th " = 1.28 (over 1 inch after 8 folds)
9th " = 2.00 "
10th " = 4 "
11th " = 16 inches (over 1 foot after 12 folds)

25th fold = 8112 ft. (over 1 mile after 25 folds)

42nd fold = 256,000 miles!!! YOU MADE IT TO THE MOON!!!!!

More advanced students amy use exponents and logarithims to get more accurate answers with less work.

Thickness = $.005 \times 2^n$
(239,000 miles = 1.51×10^{10}
$1.15 \times 10^{10} = .005 \times 2^n$
$3.03 \times 10^{12} = 2^n$
$\log(3.03 \times 10^{12}) = n \log(2)$
$12.48 = n \times .301$
$n = 41.5$
42nd fold will reach (and pass) the moon!

CONCEPT:
Exponential growth of energy use leads to rapid depletion of resources

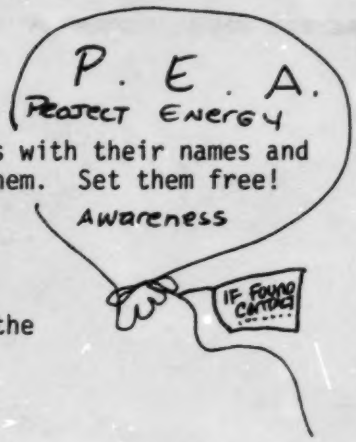
SUBJECT:
Math
Science

MATERIALS:
Pencil & paper

RAIN, RAIN, GO AWAY

55

ACTIVITY:

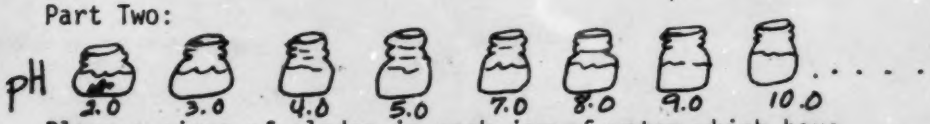


Part One:

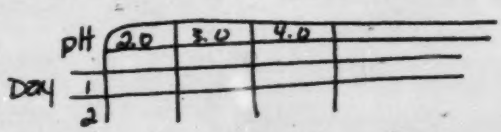
Have students let off helium balloons with their names and school address and phone number on them. Set them free!

When people call in to say where the balloon ended, mark it on a map -track the wind dispersal. This is an idea of the range that air borne pollutants can follow.

Part Two:



Place a piece of elodea in each jar of water which have varying pH. Chart the effect of the pH on the plants. Mark color changes, size changes, appearance,etc.



NOW:

Put it all together! IF an acid -pH pollutant gets into the air the pollution can be carried long distances. ACID RAIN is when the acid pollutants combine with water molecules and rain down. What effect does this have on plants? . . . mammals . . . man?

What sections of the United States are being presently studied because the effects of acid rain are so large? ANSWER: Northeastern U.S., particularly upper state of New York, Penn., Michigan, Ohio, Ill., and Lower Canada.

CONCEPT:

Acid rain is created from the consumption of our energy resources.

SUBJECT:

Science

MATERIALS:

Helium & balloons
Markers & labels
Jars
Various pH solutions
Elodea

WHO'S GOT THE HAZARDOUS WASTE?

56

ACTIVITY:

Give a small object (golf ball, stick, rock) to a group of students. Standing side by side let them try to pass it behind their backs so a single separate student doesn't know who has it. That student must try to guess who has it.

This demonstrates the need for knowledge of who is producing what, and what is being done with it.

Companies that produce a hazardous substance need to identify and label it, and notify the proper authorities so that the safety of the community can be safeguarded.

CONCEPT:
Populations are limited by available energy.

SUBJECT:
Social Studies
Science

MATERIALS:
Small object

CAN WE TAKE IT?

57

ACTIVITY:

TO STUDENTS:

This activity is to be conducted outside near an old tree stump.

You are part of a hazardous waste generating plant. It produces 1 barrel of hazardous waste per month .

The stump is a hazardous waste disposal site.

For the first 2 minutes, every 30 seconds add a barrel (a student) to the dump site (the tree stump).

Production increases due to energy demand. Now add a barrel (student) every 15 seconds.

*How many students can you fit on the stump?

*How many barrels can you fit in a dump?
(Is there a limit?)

*Could a technological device enable more students to stand on the stump? What about more stumps? Who wants a field of stumps outside their home?

*What can technology do for the disposal site? Can it solve all the problems? What are the alternatives?

CONCEPT:
Populations are limited by available energy sources.

SUBJECT:

Science

MATERIALS:

None

EXPONENTIAL GROWTH OF CONSUMPTION - A COMPUTER PROGRAM

58

ACTIVITY:

Problem for students to solve:

The U.S. has about 2×10^{12} tons of recoverable coal. Annually we mine about 8×10^{8} tons. At this rate, the supply will last 2,500 years. How long will the supply last if we increase our production by 1% annually (compounded)? by 5%? by 10%?

Answers: 327 years, 100 years, 58 years.

Though this can be done by the compound interest formula, it makes a good program for students to write by on an iterative method.

SAMPLE PROGRAM:

```
5 PRINT "INPUT RESOURCES, CONSUMPTION,
        % OF CHANGE?
10 INPUT R
20 INPUT C
30 INPUT P
35 Y = 0
40 P = P/100
50 Y = Y + 1
60 R = R - C
70 IF R L 0 THEN GO TO 90
80 C = C + (1 + P)
85 GO TO 50
90 PRINT "RESOURCE DEPLETED"; Y; "YRS"
100 GO TO 5
```

NOTE: Using this program to analyze the effect of reducing consumption may not work due to consumption becoming so small that the computer rounds it off to zero and the program gets stuck in an infinite loop.

CONCEPT:

Populations are limited by available energy

SUBJECT:

Computer Science
Math

MATERIALS:

Minicomputer or programable calculator

"WATTS UP"

59

ACTIVITY:

Have students:

Compute how much it costs to operate each of these appliances for a month: washer (700 watts), dryer (5000 watts), iron (1100 watts), refrigerator (300 watts), toaster (1150 watts coffee maker (440 - 1000 watts), vacuum (up to 650 watts) lamp (100 watts), air conditioner (750-1500 watts), TV (300 watt radio (100 watts), sewing machine (75 watts).

To compute how much it costs to operate those appliances listed above, you must know three things.

a. Wattage of appliance
b. Hours used for a month
c. What you pay per kw hour

This formula will help you be aware of how much energy you buy each month.

Wattage x hours x rate = operating rate

CONCEPT:
Access to energy source affects the growth of a society.

SUBJECT:

Math

MATERIALS:

See activity.

FLORESCENT vs. INCANDESCENT LIGHTING

60

ACTIVITY:

Have students check light bulb packages for the number of lumens produced by a bulb of each of the following:

100 watt florescent bulb
40 watt florescent bulb
100 watt incandescent bulb
25 watt incandescent bulb

Determine the efficiency of the bulbs in terms of lumens per watt by dividing lumens produced by the wattage of the bulb.

Is it more efficient ot use florescent or incandescent lighting?

Would it be more efficient to use four 25 watt or one 100 watt incandescent bulb?

Compare efficiency (total cost) of using long life vs. regular bulbs.

CONCEPT:
Some human technologies use more energy than others.

SUBJECT:

Math
Science

MATERIALS:

100 watt florescent bulb
40 watt florescent bulb
100 watt incandescent bulb
25 watt incandescent bulb

RESIDENTIAL ENERGY CHECKLIST

61

ACTIVITY:

Pass-out the following worksheets to students and have them run a "residential energy checklist" on their homes.

When they return their finished checklists have them pick 5 items that they do not presently do and DO IT to help conserve our resources.

CONCEPT:
Our energy resources can be conserved

SUBJECT:

Home Ec
Social Studies

MATERIALS:

Procedure:

The following checklist can be used by you (the student), your parents, friends, and relatives as a handy guide to systematically search for residential energy waste and potentials for conservation. The checklist does not attempt to quantify the energy loss, nor estimate the cost to alleviate the problems. In some cases it might not be practical to try to eliminate the waste, but rather to reduce it or its impact. You should refer to the specific areas in the text for further information.

RESIDENTIAL ENERGY CHECKLIST

House: The Shell	Yes	No
1. Are plants properly located around the house to provide a break against wind and shade against unwanted sun?		
2. Are drapes and furniture located so they do not obstruct heating, air-conditioning or ventilation?		
3. Are draperies insulated?		
4. Do draperies fit snugly around the window?		
5. Are exterior house doors closed quickly after use?		
6. Are lights and appliances turned off after use?		
7. Do you have storm windows and doors?		
8. Are all doors and windows properly caulked and weatherstripped?		
9. Are draperies and shades closed at night and on cloudy, windy days during the heating season?		
10. Are draperies opened to admit sunlight on sunny days in the heating season?		
11. Are draperies and shades closed on sunny days during the cooling season?		
12. Is the attic ventilated?		
13. Is the attic insulated to 6-8"?		
14. Are the walls insulated?		
15. Do floors exposed to unheated or cooled air have from 2-3 1/2" of insulation?		

	YES	NO
16. Is the fireplace damper closed when not in use?		
17. Is the den, gameroom or family room oriented to the south?		
18. Is the house shaded from the western sun?		
19. Does your home have window area equivalent to 10 percent or less of its square footage?		
20. Is your home sealed from drafts? Is it free from cracks and holes?		
21. Does your home have wall-to-wall carpeting?		
22. Does your home have fluorescent lighting where appropriate?		
23. Do all windows have drapery, shades, blinds, shutters or other covering?		
Environmental Control		
24. Are ducts, radiators or air-conditioners closed off in unused rooms or closets?		
25. Are hot water pipes insulated in unheated and uncooled spaces?		
26. Are air ducts insulated in unheated and uncooled spaces?		
27. Is the thermostat set at 68°F or below during the heating season?		
28. Is the thermostat set at 78°F or above during the cooling season?		
29. Are heating and cooling filters clean?		
30. Is the thermostat turned back at night?		
31. Are windows and doors tightly closed while mechanically heating or cooling?		
32. Is an attic fan used in the summer?		
33. Do thermostats indicate correct temperature settings?		
34. Is an outside air-conditing unit located on the shady (north) side of the house?		
35. Is the water heater insulated?		
36. Is the water heater temperature setting at 140°F or less?		

YES NO

37. Is the air-conditiong unit properly sized for your needs?

38. Do you have a heat pump?

39. Do you use natural ventilation as much as possible?

40. Are radiators and other heating or cooling equipment clean and dust free?

41. Is the water heater located in a heated space?

Housing Selection

42. If you live in an apartment, is it an "inside" apartment?

43. If you live in a mobile home, does it have a "skirt?"

44. If you live in an older home, have its plumbing, wiring, insulation and chimneys been checked by "experts"?

Food

45. Is the frost on the refrigerator and freezer less than 1/4 inch thick?

46. Is the refrigerator set at 40°F?

47. Is the freezer set at 10°F?

48. Are gaskets around refrigerators and freezers tight?

49. Is the oven used to bake more than one food at a time?

50. Is the gasket around ovens tight?

51. Are frozen foods thawed completely before cooking?

52. Is the cooking range turned off immediately after use?

53. Are dishes washed only when there is a full load?

54. Are dishes allowed to air dry?

55. Are appliances clean and dust free (particularly cooling coils)?

56. Is the oven never used as a dryer or heater?

57. Are flat bottom pots and pans used?

58. Is a timer used to avoid over-cooking?

59. Are pots covered during cooking?

YES NO

60. Is as little water used as possible during cooking?

61. Is the heated dry cycle on the dishwasher not used?

Clothing

62. Does your family dress warmer in cool weather to avoid mechanical heating?

63. Does your family dress cooler in warm weather to avoid mechanical cooling?

64. Are clothes washed only when there is a full load?

65. When washing, is cold or warm water used when possible?

66. Are clothes line dried when possible?

67. Are most of your family's clothes wash-and-wear, permanent press to avoid dry cleaning and ironing?

68. Are clothes always rinsed with cold water?

69. Is the washer located near the water heater?

70. Is the dryer lint screen cleaned after each load?

Personal Care

71. Do the members of your family take short showers or use only small amounts of water for tub baths?

72. Are all water faucets repaired and not leaking?

73. For washing, shaving or make-up is the lavatory filled rather than allowing water to run?

Entertainment

74. Are entertainment devices turned off when not in use?

75. Do members of your family try to entertain themselves rather than rely on devices?

-- If you answered with 65 or more yes's, you are truly an energy conserver and will make a good conservation advocate.

-- If you answered with 55 to 65 yes's, you are energy conscious but lack will-power or drive.

-- If you answered with 45 to 54 yes's, you are wasting energy but with minor changes could make a conserver.

-- If you answered with 35 to 44 yes's, you are an energy waster and should make an all-out effort to reform!

-- If you answered with less than 35 yes's, you are making an effort to waste energy and should consider the long range and immediate effects!!

Suggestions:

1. Distribute these checklists school-wide.

2. Try a before and after approach to using the checklist. Check before your conserving effort and after.

3. Survey students to see if their families are generally conservative or not.

INSULATING AN ICE CUBE

62

CONCEPT:
Insulating materials help to maintain cold or warm environments.

SUBJECT:

Science

MATERIALS:

Per class:
Ice cubes,
Plastic bags,
Insulating materials such as paper(varying thicknesses),cardboard, styrofoam cups, aluminum,foil, glass cups,metal cups, metal cups,plastic containers,wax paper, newspaper,foam rubber, vermiculite,sand, small wooden containers different cloth materia cotton balls.

ACTIVITY:

Organize teams of 2-3 students.

Tell students that you have collected some materials together for an interesting game. Each team will receive 1 ice cube. The goal of the game is to prevent the ice cube from melting for the longest time possible - they must keep it cool. Show the materials you can use to wrap the ice cube.

Give each group an ice cube in a plastic bag taped shut.

In order to keep track, place 1 cube in a plastic bag and suspend it by string. This ice cube will be used as a timer: when it is almost completely melted the game will end.

At conclusion, have students obtain the ice cube bags from their environments and compare the results.

Have the students identify the material which preserved the ice cube the longest. Did the thickness of the material make any difference? Ask them to think about the materials they would use if they played the game again.

IS YOUR HOUSE DRAFTY

63

ACTIVITY:

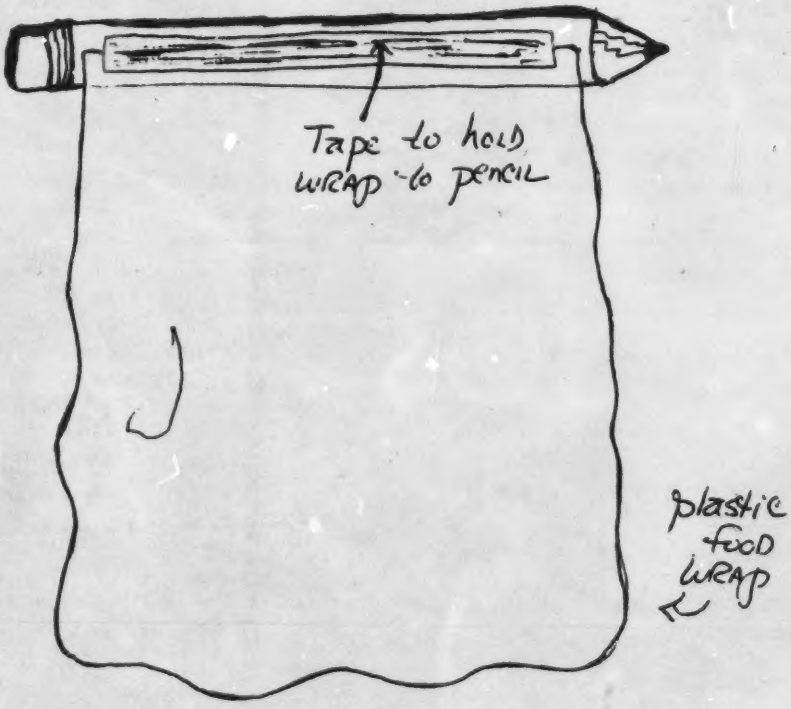
Have students make a draft meter following these instructions:

Cut a 12cm by 25 cm strip of plastic food wrap.

Tape the wrap to the pencil.

Blow the plastic gently and see how freely it reponses to air movement.

Test your home and school for air leaks by holding the gadgets near the edges of windows and doors



CONCEPT:
To demonstrate ways to save energy around home and school

SUBJECT:
Science

MATERIALS:
Per student:
Pencil
Scotch tape
Plastic food wrap

SUMMER IN THE CITY

64

ACTIVITY:

The most effective method for shading south-facing glass in summer is with an overhang. But how big of an overhang is optimal? That depends on window height, latitude, and climate. The larger the window height, the longer the overhang. In southern areas, the projection should be smaller than in northern climates (the sun follows a higher path in the southern summer sky). A tilted overhang is a shade in summer and a reflector in winter.

Select a factor according to your latitude. The higher value will provide 100% shading at noon on June 21, the lower value until August 1 . When is it hottest in your hometown?

Use this Equation:

$$\text{PROJECTION} = \frac{\text{window opening(height from bottom of window to bottom of roof)}}{F^*}$$

*F is a factor from this table

north latitude	F factor
28	5.6 - 11.1
32	4.0 - 6.3
36	3.0 - 4.5
40	2.5 - 3.4
44	2.0 - 2.7
48	1.7 - 2.2
52	1.5 - 1.8
56	1.3 - 1.5

CONCEPT:

There are many ways to help conserve energy

SUBJECT:

Science
Home Ec

MATERIALS:

Reference material

HOW DOES YOUR GARDEN GROW?

65

ACTIVITY:

These are the facts:

Large and small trees and shrubs may be used to screen out undesirable winds; conifers should be used to control winter winds.

Deciduous trees will screen out direct sunlight during the summer, to reduce required cooling loads, but allow it to pass through in the winter, reducing requires heating loads.

Planted areas will be cooler during the day, and experienc less heat loss at night.

Shelter belts and windbreaks (lines of trees) are most effective when placed perpendicular to prevailing winds.

Placing windows on the south side and minimizing them on the north side reduces heat loss.

Dark colors collect heat and light colors reflect heat.

To the students:

This is your mission should you decide to accept it:

Pick an area in the United States where you would like to live. Find some more specific facts about landscaping for conservation. Design your yard, including building orientation, and vegetation.

CONCEPT:
Energy can be conserved in many ways.

SUBJECT:

Science
Home Ec

MATERIALS:

Reference materials

THE HOME OF THE FUTURE

66

ACTIVITY:

Discuss the concepts utilized in active and passive soalr homes and other energy efficient buildings. Illustrate these ideas with plenty of A-V materials. Have each student then desighn their own idea of a "dream home", one which fits their personal taste and is energy efficient.

The student's finished product may be a model, drawing, or blueprint, depending upon the course. Each student should share the ideas with the class, with an oral presentation or written and drawn display.

Some suggestions for A-V material:
Film - "Energy from the Daystar"
Magazines - Popular Science
Mother Earth News
National Geographic, "Special Energy Issue"

CONCEPT:
Energy can be conserved in many ways.

SUBJECT:

Art
Industrial Arts
Home Ec
Science

MATERIALS:

A-V materials on solar and energy efficient homes
Drawing materials
Materials to make mode

AN ENERGY MENU

67

ACTIVITY:

Duplicate the following worksheets for each student and have them follow the instructions.

CONCEPT:

There are many ways to conserve energy

SUBJECT:

Home Ec
Science

MATERIALS:

1 Energy Menu Checklist per student
Pencils

ENERGY MENU CHECKLIST

Instructions: Review the items offered in the menu on the following pages and select your "first preferences" based strictly on likes and dislikes. Place checks beside those items in Column 1. Nest, make selections from the menu on the basis of least energy consumption. Remember, the energy cost of a food includes: fertilizers and insecticides, equipment, transportation, processing, packaging, and preparation. Place a check by each "low energy" item selected in Column 2. Then refer to the Energy Price list for eact item's energy cost. Indicate the "price" of each item you chose and determine your total bill. To discover how you might have saved energy, find the differences between the individual itmes in the two columns and enter those figures in Column 3. The differences will be losses or hains in costs. Add the total "pluses and minuses" in this column to find total energy savings. If you werer to select items for Column 1 (preferences) again, would your choices be any different?

ENERGY MENU

	1 First Preference	2 Least Energy	3 Differences (+ or -)
APPETIZERS (Choose one from each pair)			
Frozen Juice			
Fresh Juice			
Crackers (unwrapped, available to the restaurant in bulk)			
Crackers (wrapped individually, packed in small cartons)			
Butter			
Margarine			
MAIN DISH (Please make a first and second choice as we do not always carry each entree)			
Luncheon Meat			
Chicken			
Turkey			
Rice with Vegetables			
Beef (grass-fed)			
Beef (grain-fed)			
VEGETABLES (Sorry, today we have only carrots, but you may choose your preferred type)			
Fresh Carrots			
Dehydrated Carrots			
Frozen Carrots			
Canned Carrots			

DRINKS
(Please choose a first and second choice as we sometimes run short of one kind of drink at lunch)

Soft drink (in aluminum can)	_____	_____	_____
Soft drink (in returnable glass bottle)	_____	_____	_____
Milk	_____	_____	_____
Beer (in aluminum can)	_____	_____	_____
Beer (in returnable glass bottle)	_____	_____	_____

DESSERT
(Choose one)

Apples (homegrown in our restaurant's own garden)	_____	_____	_____
Apples (store-bought)	_____	_____	_____
Walnuts (shelled)	_____	_____	_____
Walnuts (unshelled)	_____	_____	_____
Ice Cream	_____	_____	_____
TOTAL BILL	_____	_____	_____

ENERGY PRICES

(Prices are proportional to actual energy expenditure)

APPETIZERS:

Fresh juice: 12¢
Frozen juice: 46¢
(Freezing and processing use a great deal of energy, both initially and for storage)
Cracker A: 10¢
Cracker B: 15¢
(Food excessively packaged or only available in small packages is more energy-intensive than unwrapped foods or foods available in bulk)
Butter: 15¢
Margarine: 5¢

MAIN DISH:

Luncheon Meat: $1.60
Chicken: 96¢
Turkey: $1.06
Rice with Vegetables: 45¢
Beef (grass-fed): $1.48
Beef (grain-fed): $2.08

(Animals are inefficient converters of protein. A pound of meat requires about four times the energy to produce and market as a pound of vegetable protein. Some animals are more efficient converters of protein than others.)

VEGETABLES:

Fresh Carrots: 12¢
Dehydrated Carrots: 92¢
Frozen Carrots: 31¢
Canned Carrots: 23¢
(Processed vegetables require more energy than fresh vegetables; freezing and dehydration especially require large amounts of energy)

126

DRINKS:

Soft Drink (aluminum can): 45¢
Soft Drink (returnable bottle): 31¢
Milk: 34¢
Beer (aluminum can): 50¢
Beer (returnable bottle): 25¢

DESSERT:

Homegrown apple: 3¢
Store-bought apple: 19¢
(Homegrown apple by commercial methods saves commerce and transport; organic methods would save more)
Walnuts, shelled: $1.04
Walnuts, unshelled: 39¢
Ice Cream: 60¢
(Large quantities of milk are used; freezing is necessary)

PROCESSING FOOD BY CANNING

68

ACTIVITY:

Students will process food by canning apples and comparing the difference between the cost of home canning and mass manufacturing.

Procedure:

Wash apple and cut into pieces. Place the apples in salt water to keep them from turning brown.

Cook apples until soft (you may need to add water), then put through a collander.

Sterilize jars and tops for a minimum of 20 minutes. While everything is hot, put applesauce in the jars and seal.

Compare the amount of energy you used in preparing the apples for canning and the amount of energy needed to prepare canned applesauce from the grocery.

Compare your cost with the cost of an equal amount of applesauce from the grocery (consider the cost of transportation, etc.)

CONCEPT:

There are many ways to conserve energy

SUBJECT:

Home Ec
Science
Agriculture

MATERIALS:

Apples
Knives
Heat source
Pan
Bowl
Salt,
Water
Collander
Canning jar
Canning lid

HOW MUCH BIO IS IN THE MASS?

69

ACTIVITY:

Infomation for the teacher:
Identify an area where you and your students can gather a local weed.

You may wish to send a small group of students to gather weeds for the entire class.

An acre contains 4085 square meters.

There is an onging experimentation with using weeds as a source of fuel. Methane gas is produced when anaerobic bacteria digest biomass material. It is estimated that one acre of kudzu, when converted to methane gas, would heat and cool a four-person home for one year.

For student experimentation:

Collect weeds (tops and roots) from one square meter of lush growth of a local weed.
Wash off the soil, dry them with a paper towel, and weigh.
Dry the plants until they are crisp, then weigh again.

Questions:

1. Would the amount of weeds in your area be useful in solving the energy crisis?

2. What normally is done with the weeds in your area? What are new uses of weeds grown in your area?

CONCEPT:
To become familiar with the definition of biomass, and recognize its importance as an energy source.

SUBJECT:
Science

MATERIALS:

Hoes
Shovels
Bags
Balance scales
Meter stick

METHANE FROM MANURE (a Student Project)

70

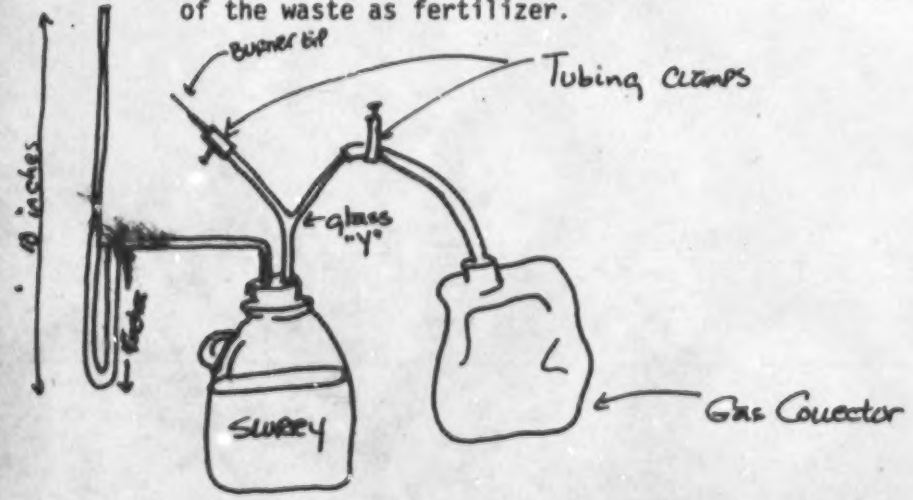
ACTIVITY:

Assemble the apparatus shown in the illustration. Get the chemistry teacher to help the students with cutting and bending the glass, forming the glass burner tip, and inserting the glass into the stopper as there are a number of safety precautions in working with glass. The burner tip should be quite long to prevent backflash. Cafeteria type of milk dispensers make excellent collector bags, just wash them out and roll them up to expel the air. Mix manure with water to form a slurry and pour into about 10 cm. from the neck. Fill the"U" of the manometer with water. Keep the apparatus in a very warm place (32 - 38 C). After a few days, the water should move to show gas production. Hold a match near the burner tip and open the clamp to if it will maintain a flame.

When you get this to occur (generally after a few weeks), you may open the clamp to start collecting the gas in the plastic bag. When the bag is full, you may place a brick on the collector and burn the collected gas.

Suggestions for further research:

a. Find the ideal temperature for the process
b. Design a solar heating system to maintain the necessary temperature.
c. What is the ideal pH?
d. How does the quality of the gas improve if you run it through a limewater solution and over rust to remove carbon dioxide and hydrogen sulfide?
e. What's the best type of manure?
f. After the slurry stops producing methane, check the quality of the waste as fertilizer.



Reference: "A Modest Experiment in Methane Production," Robert C. Mahon, Mother Earth News Handbook of Solar Power, Bantam Books, 1974.

CONCEPT:
Energy can be recycled in different ways

SUBJECT:

Science
Agriculture

MATERIALS:

1 gallon cider jug
heavy duty plastic ba
rubber tubing
2 tubing clamps
1 two hole stopper
glass tubing
glass "Y"
manure

COMPOST IT!

71

ACTIVITY:

Food and yard scraps amount to 38% of all solid wastes. Waste disposal is a costly and often unnecessary problem. You can reduce this problem by over one-third if you use all the food scraps and yard clipping from your home to create a compost pile.. A compost pile a just a mixture of decaying organic matter that can be used for fertilizer. Tiny micro-organisms like worms, sowbugs, snails, etc break down the decaying matter into nutrients into the soil so plants can take these nutrients into their system.

How to Make a Compost for your Classroom:

The following worksheet illustrates how you and your students can make a compost out of a garbage pail. Begin this project in the Fall so by Spring your students can use the results for Spring gardens and flower beds!

The following worksheet is taken directly from:
CONNECTIONS, a Curriculum in Appropriate Technology for 5th & 6th Grades, National Center for Appropriate Technology, 1980.

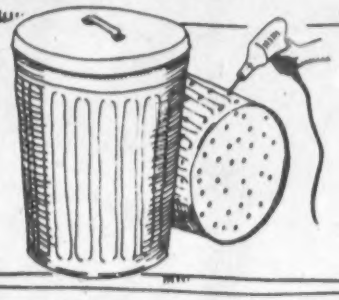
CONCEPT:
There are many ways to recycle our energy resources

SUBJECT:
Science
Home Ec

MATERIALS:
See instructions on worksheet

HOW TO MAKE GARBAGE PAIL COMPOST

1 DRILL HOLES IN THE PAIL



Use an electric drill that holds a 3/8" drill bit and make 30 or 40 holes through the bottom and lower sides of the pail as shown.

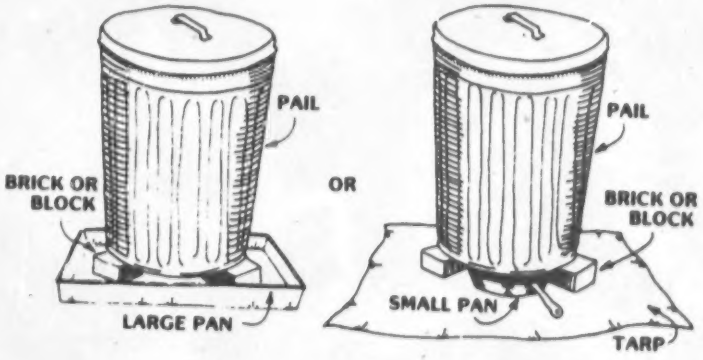
If you don't have an electric drill, have someone do it for you that has one, since this is the quickest and neatest way to make the holes.

2 SET UP THE PAIL

Since this may be a rather messy project, choose a place that won't be bothered by a composter.

Stand the pail on bricks or blocks so that you can collect the organic solution that will run out of the holes in the pail. This solution, also called "Organic Tea" can be diluted with water and used to water plants.

If you find a large enough pan, you can place the pail, bricks and all, into it. If not, set up the composter on a tarp or other suitable covering and catch as much of the "Organic Tea" as you can with any container that will fit under the pail as shown.



3 FILLING THE COMPOSTER

There are 3 kinds of materials to put into the composter:

A) GREEN MATTER (plant wastes, grass, weeds, leaves, hay, straw, kitchen scraps, etc.)

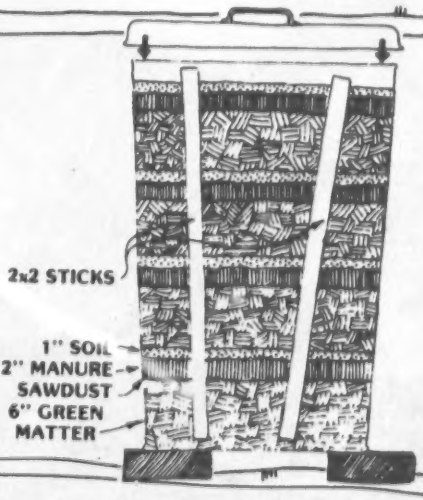
B) MANURE (fish emulsion or bone meal will work)

C) SOIL

Layer these three materials as shown. A thin layer of sawdust after each layer of Green Matter helps to reduce odor and to absorb moisture.

Place two sticks upright into the pail as shown, while filling. Chop and shred the material as much as possible to speed up the composting process.

When filled, take out the sticks (for aeration) and put the lid on.



4 COMPOST MAINTENANCE

Stir the pile once a week for aeration of the compost. It should be very hot in the center.

Keep the pile glistening moist like a sponge.

Compost should be ready in 6-8 weeks.

A successful compost has a crumbly texture, a black-brown color and earth-like odor.

An unsuccessful compost is tight, packed or lumpy, greyish yellow (dead earth) and smells musty (mouldy) or sour (too wet and dry).

BOTTLES OR CANS?

72

ACTIVITY:

Review with the class the fact that energy can be saved by using returnable bottles instead of throw-away soft drink bottles or cans. The amount of energy saved according to the reference cited below is as follows:

> The purchase of a six-pack of soft drinks in returnable bottles instead of no-deposit, no-return containers will save the energy equivalent of 1½ pints of gasoline. The saving of 1½ pints of gasoline can take the average family car about 2½ miles. Additionally when the empty bottles are returned for the 30-cent deposit the six-pack purchase will have cost 18 cents less than for throwaways.

Involve the class in some mathematical computations. How much energy equivalent in gasoline will each family represented in the class save if they purchase one or two six-packs of returnable bottles each week for one year? How many miles of automobile travel are possible? How much money is saved? What are the total amounts for the entire class?

Since this appears to be such an easy way to save energy why do we still find so many person buying beverages in throw away containers? What, if anything, might or should the government or people do about this matter?

CONCEPT:
Energy can be conserved in many ways

SUBJECT:

Math
Science
Social Studies

MATERIALS:

None

135

RECYCLING PAPER

73

ACTIVITY:

Distribute the following worksheets to your students and have them read and do the suggested activities. These activities were taken directly from :

CONNECTIONS: A Curriculum in Appropriate Technology, National Center for Appropriate Technology, 1978.

CONCEPT:

Energy can be saved in many ways

SUBJECT:

All areas

MATERIALS:

See worksheets

Man in the Environment

Man began as a simple omnivore who gathered fruits, nuts, and seeds; who killed and ate animals smaller than himself – and was then prey for the larger carnivores. He was an integral part of a functioning ecosystem. He was a part of the web of life – of no more importance than a plant, a bird, or a fish. But that was earliest man.

As man developed into an agriculturalist, he began to have more impact upon his environment than the other animals around him. He disturbed the soil, transported and distributed seeds, and diverted water for irrigation. His impact was still light, but increasing.

Although man appeared on earth well over a million years ago, his populations increased almost imperceptibly until he became a farmer – but the increase began to be noticeable. Even then, human populations amounted to only about a quarter of a billion by the beginning of the Christian era. By 1820 the world contained a full billion – and only 110 years later, in 1930, another billion had been added. Only 30 years later, in 1960, there were three billion people on earth and in 1976 there were four billion. It is predicted that by the year 2000 the population will exceed six billion.

As human populations increased, human needs increased to the same degree. Man needed more plants and animals for food, clothing, shelter, and warmth. And, as he became a tribal or communal animal, man began to develop wants as well as needs. When one superior man developed a bow and arrows, or a better stone axehead, other men wanted the same for themselves.

In more modern times, needs have increased faster than populations because a more complex society creates more needs – but man's wants have increased exponentially. This formula of increased populations times greater needs, times increasing wants, has put stress upon natural resources. The procedures of harvest and processing of these resources have created additional impacts upon the environment. Man's technology may supply needs, but it also creates wants, and these same technological processes can interfere with natural cycles and systems.

Certain parts of the natural environment are irreplaceable. Living resources are renewable; plant and animal resources are renewable – but can be destroyed. And with their destruction comes interference with natural cycles such as the carbon, water, and oxygen cycles. No life on our earth can exist without these systems.

Concentrations of human populations often lead to environmental deterioration. When man lived in family groups he was forced to move from time to time because he had harvested the plant and animal resources to a level where it became difficult to feed himself. But he was also forced to move when the accumulation of his wastes became unbearable.

Modern, metropolitan man brings resources from the far corners of the earth and builds permanent dwellings. He finds it difficult to move – and his wastes have become a major environmental problem. Not only does he have the scraps from his table and his body wastes to dispose of, but also quantities of effluent from his technology which become increasingly difficult to dispose of. Such materials as radioactive wastes, industrial chemicals, and pesticides or herbicides are difficult to dispose of in a safe and proper manner. In some cases the technology for disposal has not been developed.

The masses of daily waste – garbage, rubbish, and industrial trash – have become burdensome in quantity. A quality environment can no longer be sustained when these wastes and by-products are dumped into rivers, lakes, and oceans or hidden in land-fill dumps where their leachings create further problems.

Our very complex society promotes conflict between man's needs and wants, and the quality of the environment. Almost anyone living in this country must have transportation in order to get along. So, at the present time, and automobile may be classed as a need – yet automobiles are the major contributor to air pollution in urban areas. Other forces, manufacturing and advertising, push to sell more, bigger, and newer cars in order to keep employment up and for the stockholders' invested money to bring reasonable returns. None of these things are wrong – it is important that people can receive a return on their investments, or there would be no money available for medical research, education, or other important social needs. It is important that the factory hums – because hundreds or thousands of people depend upon it for a livelihood. But there are conflicts between the needs for transportation, the desires for newer and bigger cars, and a livable environment.

Modern man's consumptive practices and patterns are constantly changing. Items once made of wood are now made from petrochemical-based plastics; steel and iron are replaced by aluminum or magnesium; and the volume of materials processed increases exponentially. Newer models are available yearly – with intensive promotion of the idea that "newer is better." We have been called a "throwaway society" – we are certainly a wasteful society – and the rest of the world seeks to emulate our lifestyles.

How can we plan for the future availability and use of oil? Should we continue to use petroleum as a source of energy, or, in the long-term best interests of mankind, should we conserve this limited resource for its uses in medicine, agriculture, certain plastics, the lubrication of essential machinery, or other, carefully chosen uses? Can we continue to increase our uses of wood products from limited forests – or should we develop a massive recycling of used materials into the system?

If man is to reduce the drain upon finite natural resources and to reduce the environmental impacts, there must be long-range planning not only to meet the natural resource needs of future generations, but to assure a healthy environment for ourselves as well as the future. Such planning, to be effective, must include not only scientific, but social understandings, and must proceed toward particular objectives.

Economics alone should not be the criteria for resource use and management. Perhaps some decisions will not be economically sound – we must be willing to pay the differences...

Increased populations, the concentrations of those populations, and current life-styles have contributed

137

significantly to a massive increase in per-capita waste. Man is literally being inundated by his own waste.

In 1900, each American used an average of 58 pounds of paper per year; by 1973 this figure had increased to 639 pounds per year. In 1970, 5.3 pounds of solid waste were produced daily by each man, woman and child in our country. By 1980, that waste is projected to be 8 pounds per day. This amounts to over 387 billion pounds of solid waste produced each year. If this waste was equally distributed over Arizona, it would bury the state to a depth of 7 feet in a single year.

What do we throw away? A typical ton of waste in the U.S. contains approximately 920 pounds of paper products; 440 pounds of food and yard wastes; 200 pounds of glass; 160 pounds of metal; 140 pounds of wood, and 140 pounds of cloth, rubber, plastic and leather.

To decrease the amount of solid waste that man generates may require modifications of individual and cultural value systems and individual lifestyles. Such changes may not be feasible. A practical approach might be to accept increasing amounts of solid wastes and concentration on methods of utilizing waste in a productive manner. Waste materials cannot be thrown away – Dr. Barry Commoner has reminded us that "there is no such place as away." The materials go somewhere and have a variety of effects upon our environment.

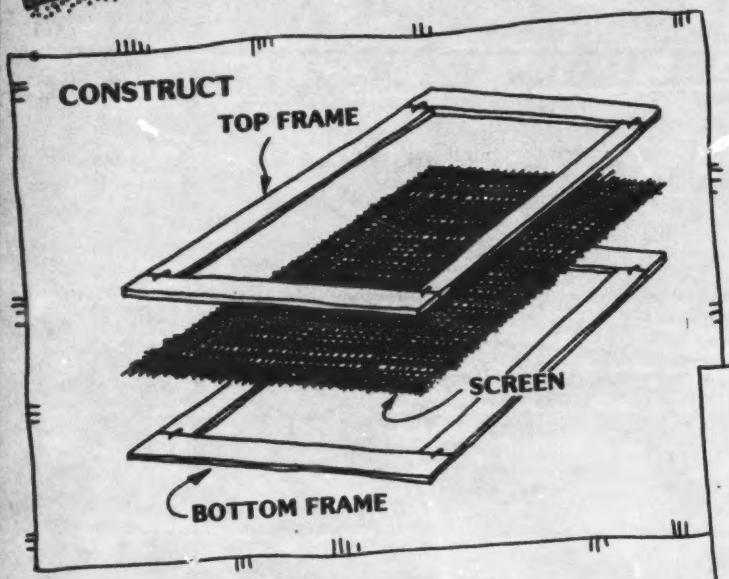
The ideal situation would be a two-fold approach to the problem – a modification of value systems and an intensification of recycling and reuse of all waste. Today's recycling of aluminum, glass, tin, and paper are only beginnings. The future must bring a recycling and reuse, in some form, of all waste.

*From: **Teachers' Resource Guide for Environmental Education,** Arizona Dept. of Education.

Helpful Hints in Making Paper

1. To save time, most of the pulp can be prepared the night before. If you make it much in advance, it should be refrigerated or it will ferment.
2. Using a few strips of colored construction paper makes the pulp prettier. Don't try to use dyes as they are messy and harder to work with.
3. The ratio of pulp to water is crucial. Experiment with it ahead of time by making a few sheets for yourself. The ratio is about 2 cups water to 1/2 cup shredded paper.
4. Pulp should be distributed on screens as thickly and evenly as possible before the screen is tilted to wipe off excess water. It will be easier for the students to pull the new paper off the screen if the pulp is about 1/16 to 1/8" thick.
5. Newly made paper should be left to dry on newsprint for a few days. Students' names can be marked beside their pieces of paper if they want their own.

HOW TO MAKE RECYCLED PAPER

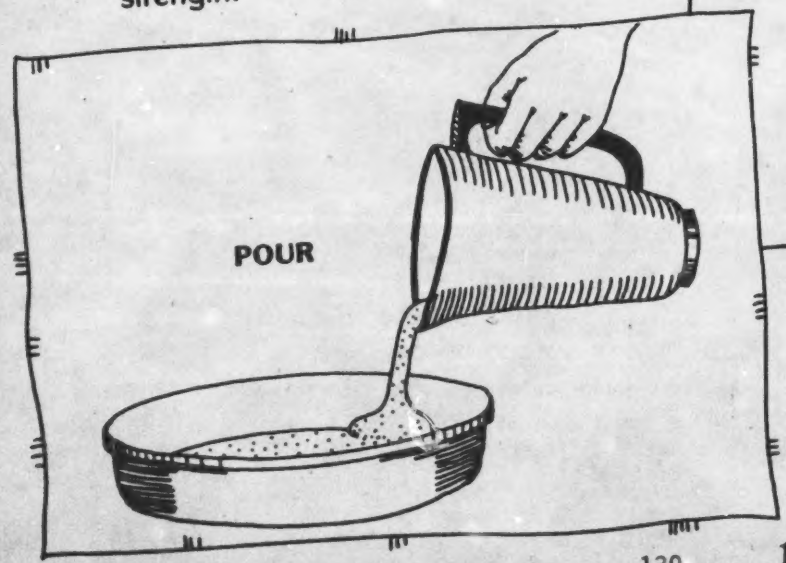


1 FIRST YOU NEED A FRAMED SCREEN, LIKE THIS:

Use thin pieces of wood to make the top and bottom frames.
Staple the screen to the bottom frame only.
Staple corners of wood frames together on top and on bottom.

2 THEN, YOU NEED THE PULP:

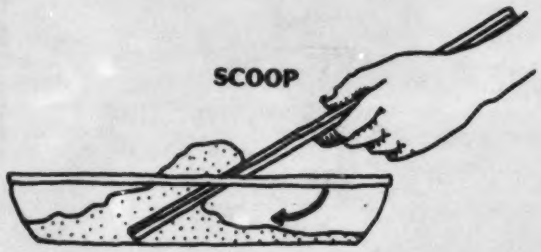
A quick way is to tear up some waste paper into tiny peices, put it in a blender and add a little water. About 1/2 page of newspaper will do. Add 1 T of cornstarch for strength.



After this is thoroughly blended to a pulp, pour it into a tub or pan, large enough to dip the screen into.

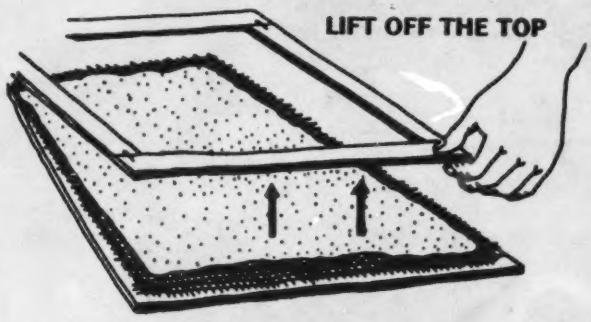
Pulp should be like split pea soup.

3 NOW COMES THE HARD PART:



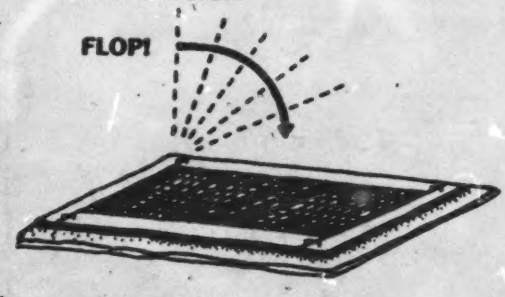
You have to scoop up the pulp out of the tub with the framed screen so that most of the water drains out. Make sure the pulp is on evenly.

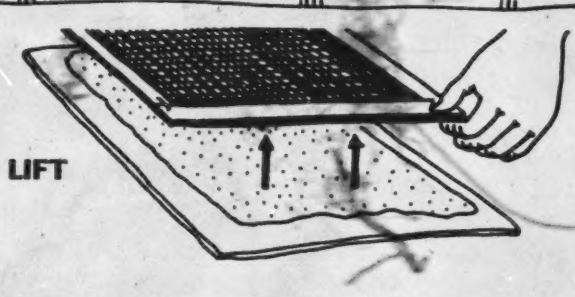
Next, tilt the frame up and wipe off the bottom of the screen to give it a smooth finish and to get out excess water.



Lift off the top frame, but be extra careful not to break the edges of the pulp.

Flop the bottom frame and screen over onto a white felt square and press down with another piece of felt to get out more water.





Now carefully lift the screen off. Take the paper over to newsprint and peel off the felt. Leave paper for 24 hours.

DON'T THROW YOUR TREES AWAY

Each ton of paper that is recycled replaces and preserves an acre of harvestable trees.

The recycling of paper reduces waste and garbage pollution.

Recycling old paper uses 50 percent less energy than making new paper from trees.

141

AN ENERGY FAIR

74

ACTIVITY:

Have students organize and conduct an "Energy Fair" one weekend. Through a steering committee composed of students from a class,club, or student council, solicit assistance from students and teachers in the various subject area at your school.

Social studies students could illustrate a history of individuals and events involved in energy development; a history of energy consumption pattersn; a pictoral display of factors that led to our present energy problems; and a list of governmental agencies and institutions with responsibilities for developing energy resources. A list of energy education conservation materials would be of value to students, teachers, and citizens. Determine what agencies and institutions already have materials that could be distributed at the Fair.

Science students could prepare "fact sheets" on energy production and possible economic and ecological trade-offs; exhibit some basic energy concepts such as photosynthesis; prepare displays on solar cells, wind mills, electric motors, and insulation materials. An exhibition of careers related to energy development would be of value to students and parents.

CONCEPT:

Energy can be conserved in many different ways

SUBJECT:

All areas

MATERIALS:

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